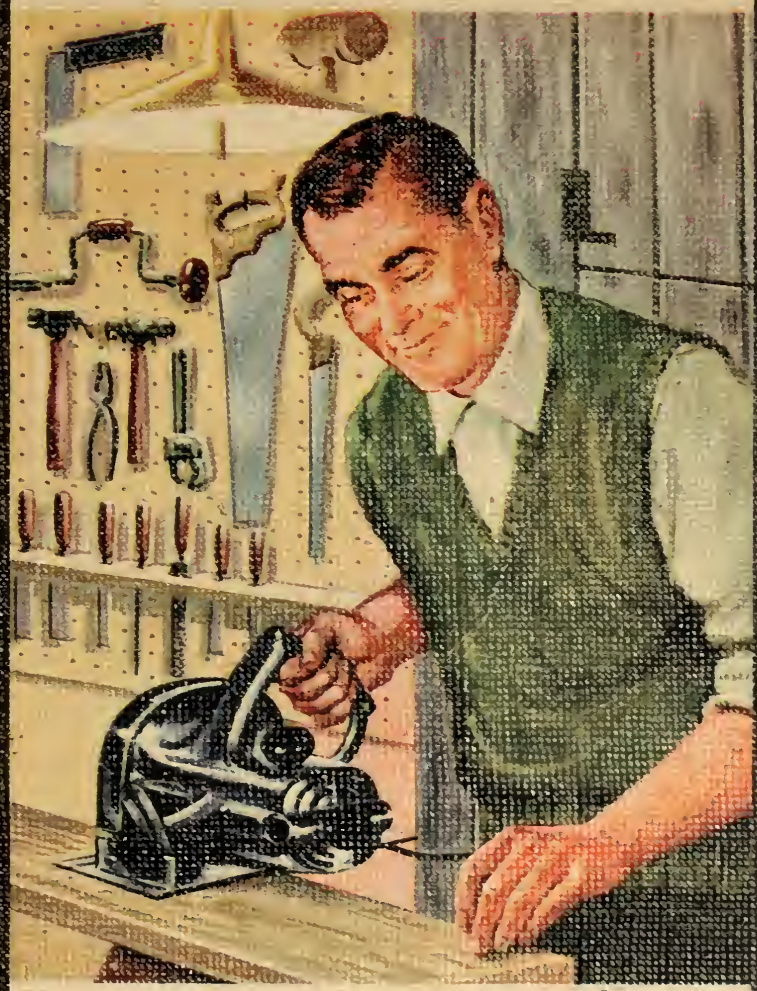
POPULAR MECHANICS

ILLUSTRATED

HOME HANDYMAN

ENCYCLOPEDIA & GUIDE



The POPULAR MECHANICS

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ENCYCLOPEDIA & GUIDE

EDITED BY THE STAFF OF POPULAR MECHANICS

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Good landscaping is as tidily decorative with its basic evergreens under snow as it is in summer when flowering shrubs bloom

THE TEST OF GOOD LANDSCAPING.. THAT YEAR-ROUND EFFECT

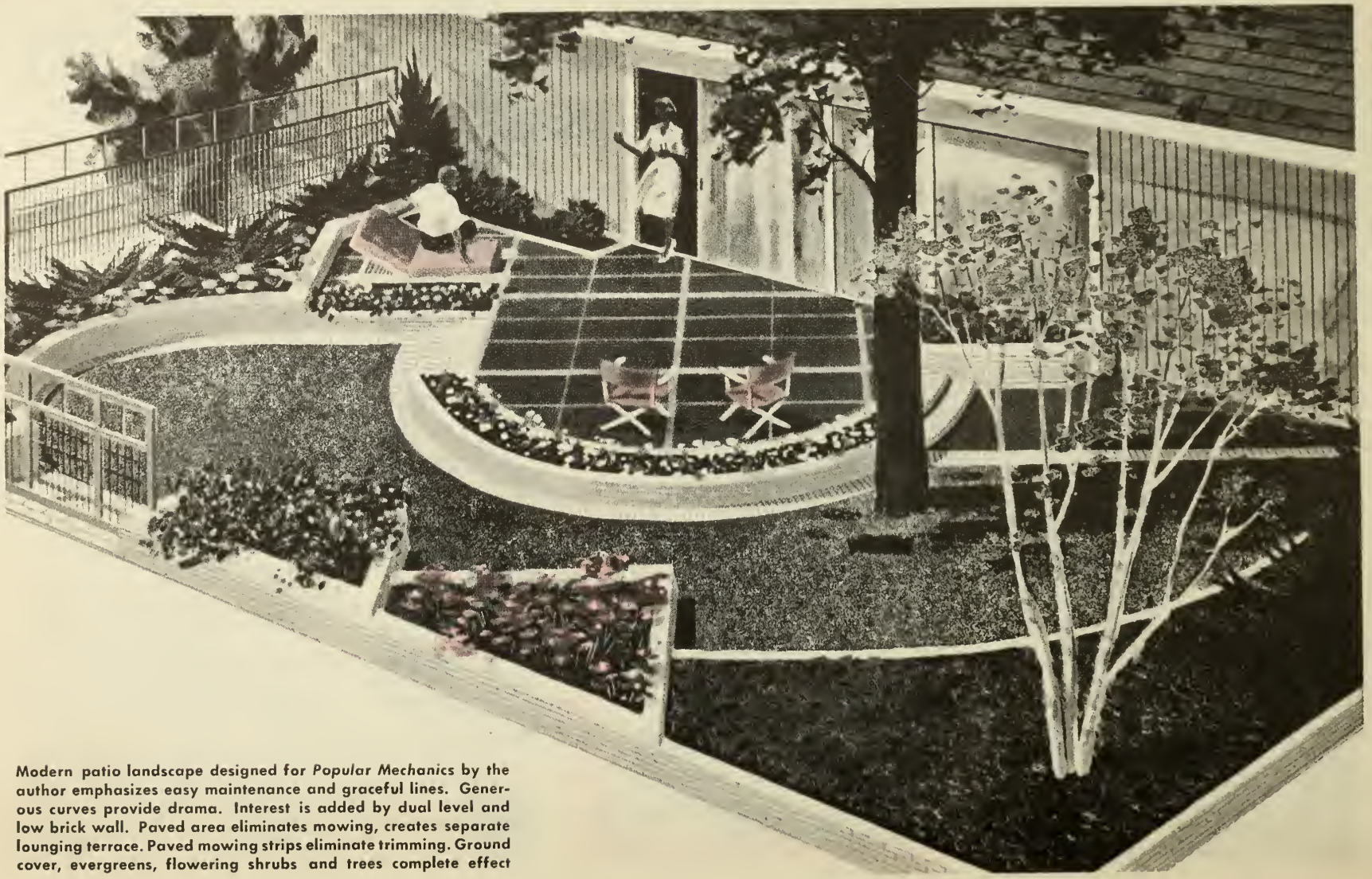
By *Harold O. Klopp*
LANDSCAPE ARCHITECT

TOO BAD you can't see the place in another six weeks, when the 'mums are in bloom."

"Sorry the yard's such a mess — you should have seen it last month when the spring bulbs were at their peak."

If you're an apologetic gardener who constantly hears himself making remarks like these in spite of the fact that you work like a demon with hose, fertilizer, trowel and seed catalogue, you have lots of company. Chances are you're the victim of an easily remedied deficiency suffered by all but the professionals and a relatively few knowledgeable amateur gardeners: There's something basically wrong with your landscaping.

The traditional "flower garden," grown in precision-edged patches cut out of the lawn and banked with assorted annuals so everyone can see the display of color each summer, presents one of the toughest maintenance jobs possible. What's worse, the carefully cultured blooms are gone in a few months. During the remainder of the year the "garden" is a patch of scraggly brown stems intermingled with a spattering of struggling green plants, unreachable



Modern patio landscape designed for *Popular Mechanics* by the author emphasizes easy maintenance and graceful lines. Generous curves provide drama. Interest is added by dual level and low brick wall. Paved area eliminates mowing, creates separate lounging terrace. Paved mowing strips eliminate trimming. Ground cover, evergreens, flowering shrubs and trees complete effect

CHART FOR YEAR ROUND BEAUTY

NORTHERN AREAS

Trees

Evergreen

Norwegian spruce
Blue spruce
Douglas fir
Canadian hemlock
White pine
*Red pine
Eastern red cedar
*Juniper

Deciduous

American maple
*Japanese maple
*Japanese cherry
*Chestnut
Alder
*Amalanchier (Juneberry)
Birch
*Redbud
*Flowering dogwood
Hawthorn
*Beech
*Silverbell
*Magnolia
Flowering crab
Weeping and corkscrew willow

Shrubs

Evergreen

*Azalea
*Catawba rhododendron
*Japanese andromeda
*Mountain laurel
*Dwarf Japanese yew
Horizontal juniper
Mugo pine
*Arborvitae

Deciduous

Dogwood (red)
*Pagoda dogwood
*Cornelia cherry
*Cottoneaster
Russian olive
Euonymus alatus
Witchhazel
*Oregon grape holly
Sumac
Buffaloberry
Wayfaring tree
Nanny berry
Blackhaw
Warminster broom
Viburnum carlesi

*Asterisks above indicate trees equally desirable in South.

SOUTHERN AREAS

Trees

Evergreen

Cedrus
Cypress
Pinus excelsa
English yew

Deciduous

Southern hackberry
Ginkgo
Japanese honey locust
Sweet-gum
Magnolia
Oak
Kadsura tree

Shrubs

Evergreen

Pyracanthus
Buxus
Carolina rhododendron
Camellia japonica
Holly
Abelia

Deciduous

Cork maple
Deutzia
Hibiscus
Tennessee false indigo
Beauty fruit
Blue spirea
Sweet fern
Daphne
Jasmine

Ground Covers

Sun or Shade

Ajugga geneuensis (evergreen—blue flower)
Euonymus radicans (evergreen—white-orange berries)
Iberis sempervirens (evergreen—white flower)
Vinca minor (periwinkle) (evergreen—blue flower)
Hedera helix baltica (evergreen-inconspicuous flower)
Violets (perennial—white and blue flower)
Sedums (perennial—various flowers)
Euonymus colorata (perennial—variegated leaf)

Shade Only

Pachysandra (evergreen)
Lily of the valley (Perennial—white bell)

Sun Only

Creeping thyme (perennial—white, lavender blue flower)
Lonicera japonica (perennial—pink flower)
Rose wichuriana (perennial—white flower)
Rosa Max Graf (perennial—silver-pink flower)

weeds and inevitable sprays of thriving crabgrass. More often than not, the space it occupies, chosen for display from the street, walk or kitchen window, is lawn area that you and the kids could use for lounging or play.

Oddly enough, in most cases it is easier to have a garden you'll be intensely proud of not just three months a year, but virtually all year 'round; one that will make the most of your yard space so everyone can enjoy it. In such a garden, plants that have finished blooming form decorative green banks as a backdrop for other blooms that are on the way. It can, in fact, look like the corner of a lavish estate *all* the time. And the most startling fact is that all this can be meticulously maintained in a fraction of the time you would have to spend on frustrating flower patches.

The simple secret is landscaping — in a word, planning. Good planning calls for a written list of all your family needs and desires. Talk it over and get everyone's ideas. A contemporary garden is not just something to look at from the street. It is for people—a place they can use and enjoy. It can and should be a part of outdoor living for every member of the family.

Careful selection of plantings, plus a few techniques we'll discuss in this article, can make it possible to organize your beds so that you won't be a slave to a garden that never looks right. Whatever you do, don't go out and haphazardly buy flowers, shrubs and trees. What should you do, then?

First, make a scale map of your property on graph paper, indicating the position of your house on the plot. All trees, rocks, embankments, slopes and the direction of any view worth emphasizing come next. These are all natural features that can be exploited in a garden, even though some of those rocks and ridges may seem like ob-

Rocky outcrop in the garden can become part of the decorative scheme with interesting rock plants such as "hen and chicken" cluster. Quarter is for size

Effective use of euonymus colorata variegated as a ground cover around a curious birdbath adds a spot of texture to make an interesting garden corner

Many ground covers have blossoms or fruits that spatter color across broad areas, such as the berry-laden euonymus radicans vegetus, above. Below is vinca minor (periwinkle), favorite in sun or shade

stacles at first. Sedums, mosses, perennial rock plants and small horizontal evergreens can make a high point of interest out of an ugly rock.

As you chart these features, try to visualize your yard in areas that can be set apart by plants, with perhaps the addition of a few strategically placed shrubs such as yews, junipers, dwarf Japanese maples and the like. Be careful of towering vertical varieties, since they tend to create a "fence" or "hedge" unless expertly treated as accent units, or for special purposes.

Once you've determined the likeliest positions for these first planting beds, use bold, sweeping lines in outlining their contours. Growing shrubs and plants will soon overrun sharp curves, wiggles and angled corners. Long, bold curves tend to maintain their over-all design.

In plotting the "area divisions" of your land, these are things to consider:

Privacy. You'll want a section of lawn where you can sit, entertain and perhaps barbecue a picnic supper without making it necessary for the neighbors to see and hear everything that's going on. They may not enjoy it any more than you. This is

Combinations of ground-hugging plants make for interesting variety, such as the Queen Anne's lace mixed in with ajugga geneuensis in garden above

Points of high interest in a garden can be created with simple ingredients shown here—a rock, a funkia spectabilis, euonymus colorata variegated and ferns

one place where tall, screening evergreen shrubs and trees—such as juniper, rhododendron, cedar and hemlock—can provide a gracefully curving wall of informal privacy, creating a secluded nook without presenting the cold, formidable barrier of a high wall or fence. Banked with low flowering shrubs, border perennials or, even better, low ground cover to mark the contour of the bed, such a green wall can present all the cool seclusion of a forest glen. A tiny pool, or even the grill itself set on a flagged dais a few inches higher than the lawn can provide a fine center of interest in such a quiet corner.

Play area. The kids have to have their fun, so don't cheat them out of their place in the sun. Someplace, allow for a broad sweep of tough lawn where badminton can be set up, croquet wickets staked out or a bow and arrow range contrived. It should be spacious enough for a good game of three-cornered "catch," and can be marked off by natural contours or suggestively de-

Deft artistic touch may be applied to a garden with a single accent tree like the lacy corkscrew willow shown at right

fined by small beds with tough bordering shrubs.

Utility. Drying area, burning area, off-street parking space, storage nooks for building materials and compost, space for a small vegetable or fruit garden, all should be worked into the master plan with careful thought to convenience as well as design.

There are many ways to separate even a small yard into areas, but the best way is to utilize the natural formations on the land. Be sure to take advantage of those variations in grade, even if the grade change is only 6 inches in 50 feet. Flat ground or a flat slope is monotonous and hard to landscape, whereas great interest can be created if you're lucky enough to have uneven ground. Even the tiniest slope can be terraced with low-lying, curved walls of flagstone or thin random slabs of shelf rock, creating unique and pleasing garden areas on separate levels.

Fences, Walks, Patios...

This brings up the all-important matter of fences, walks, driveways, patios, tool sheds and other architectural structures. These form the main framework of your garden and should be handled carefully. You can make them assets or eyesores. A rough-hewn rail fence, brick or stone wall banked with shrubs and perennials, or laced with ivy can incorporate itself beautifully into almost any garden. A well-designed tool house, nestled in flowering shrubbery and graced with an inviting brick or flagstone walk can look as though it belongs in the garden.

Walks, drives and patios should fit into the garden design, and not be set apart by traditional hard, straight lines of squared-off paving. If such paving is already in, pave additional areas to give pleasing lines and curves. Try not to break up these lines in disjointed segments. Tie in your walks, driveway and garden planting areas with generous, graceful curves which are far more restful to the eye. And be sure to take into consideration the color in your paving material, gravel and outside painted surfaces just as carefully as you would handle an indoor color scheme. In selecting your flowering shrubs and perennial plants for the beds, keep in mind the colors that the blossoms will impose against these backgrounds.

One of the most important factors in a garden is ease of maintenance. The traditional garden, with its great variety of plants), set out in formal stylized symmetry in a vast profusion of color, made for plant material (largely annuals and potted plants), set out in formal stylized symmetry in a vast profusion of color, made for the highest and most expensive maintenance. The modern garden we're talking about makes use of evergreens, flowering shrubs, ground covers that perpetuate themselves year after year, plus a few well-spaced masses of blooming plants (largely perennial) for dramatic effect. Easy maintenance doesn't just happen. It must be planned. While there is no 100-percent workfree garden, there are degrees of care that certain types of planting require. Here's a rule-of-thumb list for guidance:

Easy maintenance: Paving, gravel and flagstone in heavily used areas; trees; slow-growing shrubs; ground covers where grass is hard to grow and to create borders.

Medium maintenance: Lawn, perennial flowers.

Heavy maintenance: Annuals, tubbed plants, vegetables.

Keeping your maintenance to a minimum comes with experience, but there are many pitfalls you can avoid at the outset by proper planning. The use of paved terraces in garden areas can eliminate a lot of mowing. Many materials are used today which are highly decorative and interesting. Flagstone, of course, is handsome but expensive. However, I have seen gravel used with great effectiveness. Broken chunks of concrete can be cleverly arranged in random paving. Some western gardens have terraces paved with natural round disks sliced from the trunks of redwood trees. Easterners could do the same with cedar. Old used pink brick set in a bed of sand can make a handsomely textured terrace pavement.

Paved mowing strips along the planting beds eliminate the need to hand trim the lawn edges. Made of stone slabs, clay tile or brick, such edgings will enhance any garden.

Low walls of brick or dry stone construction look as though they belong in a garden. So do paddock-type or rough-hewn rail fences. And don't overlook the decorative value of oddly shaped boulders, a low table made of natural rock slab or an interesting piece of driftwood made into a table or bench. Best of all, such items decorate the garden without the perpetual trimming required by hedges and shrubs. If you must have a hedge, make it of hardy evergreens, in the North, or of slow-growing evergreens in the South, so trimming is necessary only once or twice a year.

Terracing, besides breaking up your garden into pleasant-looking sectors, creates easier maintenance, so pay careful attention to grade.

In selecting your shrubs and plants, remember that they all will grow. So check

the mature height and spread of each variety before you put it in, and plant it with proper spacing to allow for growth. This way, they'll take care of themselves and you won't spend the rest of your life transplanting or trimming to keep the place from going to jungle. This can be time-consuming, frustrating and expensive, since transplanting is difficult.

Plan Ahead

Another important item to cut down on future labor is proper soil preparation *before* you begin your beds. It's much easier to mulch and fertilize a bed when it is barren than later on, when the plants are deeply rooted. Once a well-prepared bed is planted, a minimum of cultivating each spring and fall will keep it rich and loamy.

Things to avoid assiduously if you want an easy-to-maintain garden: formal design, sharp curves, straight lines and isolated shrubs.

Probably one of the most satisfying solutions to good landscape design, easy maintenance and a year-round effect is ground cover. For years, such ground covers as pachysandra and periwinkle were considered only as substitutes for grass in places too shady to grow lawn. Today, most good landscape architects hungrily seek new varieties, along with the tried and true varieties, to create vast areas of interesting form, line and texture that will stay green 12 months a year.

Ground Cover Is Versatile

Some of the things you can do with a ground cover are truly amazing. A few years back, attempts to achieve a balance between the height of a house and its setting resulted in a moustache of foundation plantings that soon towered to second floor windows, crowding for space and crying for a saw. Today, horizontal balance is achieved with large masses of ground cover planted in wide, generous beds, with a few accent trees or shrubs strategically spotted in an attractively textured mat of thick ground cover. These ground-hugging plants can also be used effectively in garden beds to pull scattered plantings together.

Five yews, for instance, planted like a row of periods, will suddenly melt into a beautifully textured unit design if a bed of ajugga surrounds them. Points of high interest in a garden can be created by a few simple, easy-to-maintain types of ground cover. Euonymus colorata, a boulder, a funkia and a couple of ferns can make a magazine picture out of an ugly stone jutting from the lawn. Ground covers, besides their decorative function, still serve well in places too shady or sour for grass to grow—such as under trees, under eaves where rainwater drips and creates bare spots, in hard-to-mow places, on steep embankments to hold soil together. Anywhere you use them, try to create interesting patterns and use the vertical accent of a tree, shrub or boulder here and there to break the horizontal monotony.

In Color All Year

Virtually all the plants we've discussed here will keep their form and color through all the seasons. Many evergreen shrubs, such as the japonicas and laurels, provide a mass of exotic blooms each spring as a bonus, and so do many ground-cover plants (see chart). There is hardly a season, in fact, when you can't have some blossoms blazing away in your year-round landscaped garden. Even in northern winters, the little erica carnea King George—a one-foot-high evergreen — bursts into five months of continuous bloom that more often than not has a blanket of snow for a background. Even without such spectacular plants, the stark, lacy branches of a white birch, a sugar maple, a dogwood or a pin oak tree can be a decorative asset to a snowbound northern garden that is well landscaped and held together with evergreens.

In spring, of course, masses of color burst from an endless assortment of easily maintained shrubs, trees and perennial plants. Clumps of forsythia light up the dark evergreens like spots of bright sunshine; dogwoods, fruit trees and lilacs spatter color against the sky; japonicas and deciduous shrubs are puffballs of bloom; borders come alive with bulb plants (planted in clusters amid decorative boulders); peonies make their dramatic debut, and even some ground covers become beds of solid blossom. In springtime a year-round garden is at its colorful height.

Summer finds blossoms on some rhododendron varieties and althea (hibiscus syriacus). Hundreds of perennial flowers (planted in masses of single varieties for dramatic effect) make it possible for even the busiest homeowner to enjoy a display of color in a well-planned garden throughout the summer with a minimum of care.

Fall, for some obscure reason, is thought by most northern people to be limited to chrysanthemums. This is far from true. 'Mums are a great asset to any year-round garden, since their leafy foliage forms a soft green cover all summer. But a carefully landscaped garden of trees, shrubs and perennials can literally burn with a wide variety of other blossoms through the chilly months. The blazing colors of turning leaves on maples, oaks, euonymus shrubs, dogwoods, can be fringed with

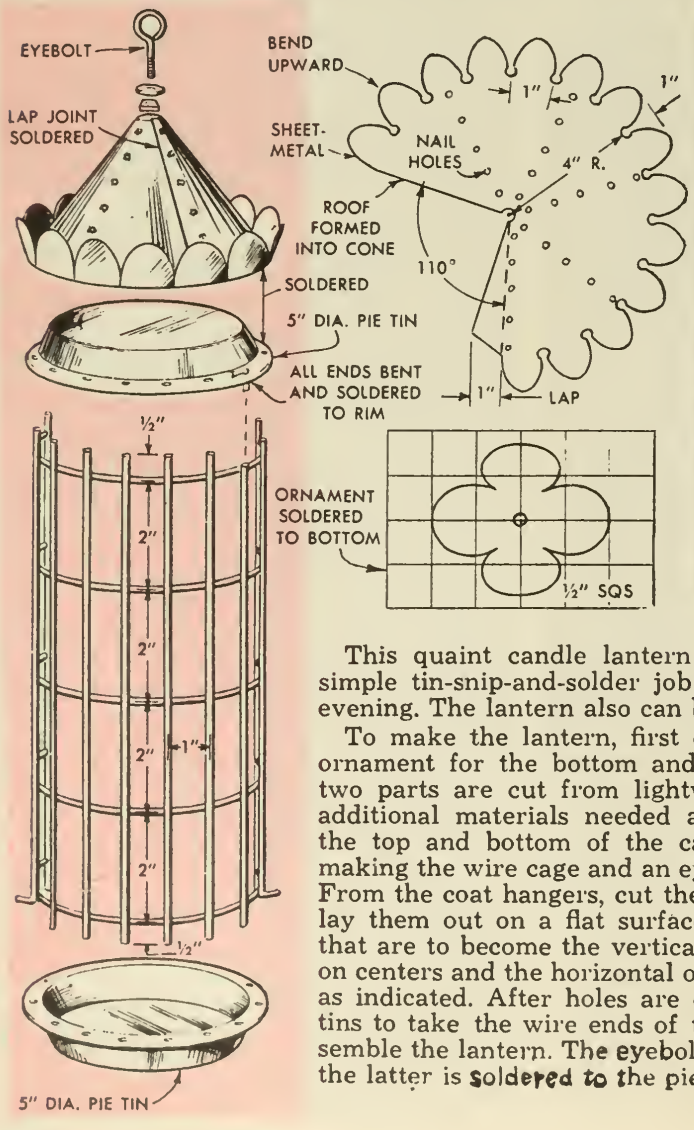
hardy flaming asters, bronze heleniums, monkshoods, Japanese anemones, tall hibiscus or mallow. One group of clematis (heracleifolia davidiana), and crocus-like colchicums will bloom well into October as far north as the Canadian border.

There are many other late-blooming shrubs and perennials if you take the trouble to seek them out. But none will look like much unless your garden is planned to make the most of each seasonal display. That means good landscaping. At the risk of some repetition, these are the inside tips that are the key to achieving a garden with a year-round effect:

- Use of bold forms in planting lines.
- Skillful use of evergreen materials.
- Choice of plants with interesting form, texture, branching or bark.
- Utilization of every change in the grade of your land.
- Use of trees and tall shrubs for accent in design.
- Attention to color of architectural materials (paint, brick, etc).
- Attention to overhead branches for sky pattern, light and shadow.
- Attention to lines and patterns created by walks, drives and patios.

★ ★ ★

Mexican Candle Lantern

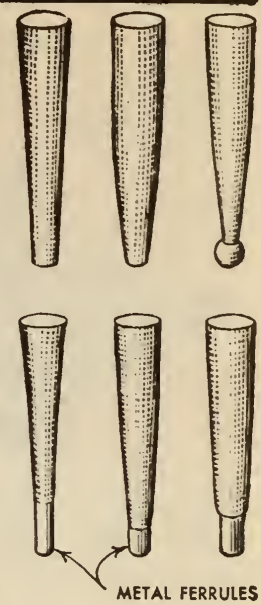


This quaint candle lantern from below the border is a simple tin-snip-and-solder job that can be completed in an evening. The lantern also can be used as a planter if desired.

To make the lantern, first draw full-size patterns of the ornament for the bottom and the cone-shaped roof. These two parts are cut from lightweight sheet metal. The only additional materials needed are two 5-in.-dia. pie tins for the top and bottom of the cage, several coat hangers for making the wire cage and an eyebolt for hanging the lantern. From the coat hangers, cut the required lengths of wire and lay them out on a flat surface to form squares. The wires that are to become the verticals of the cage are spaced 1 in. on centers and the horizontal ones are spaced 2 in. on centers as indicated. After holes are drilled in the rims of the pie tins to take the wire ends of the cage, you are ready to assemble the lantern. The eyebolt is attached to the roof before the latter is soldered to the pie tin at the cage top.

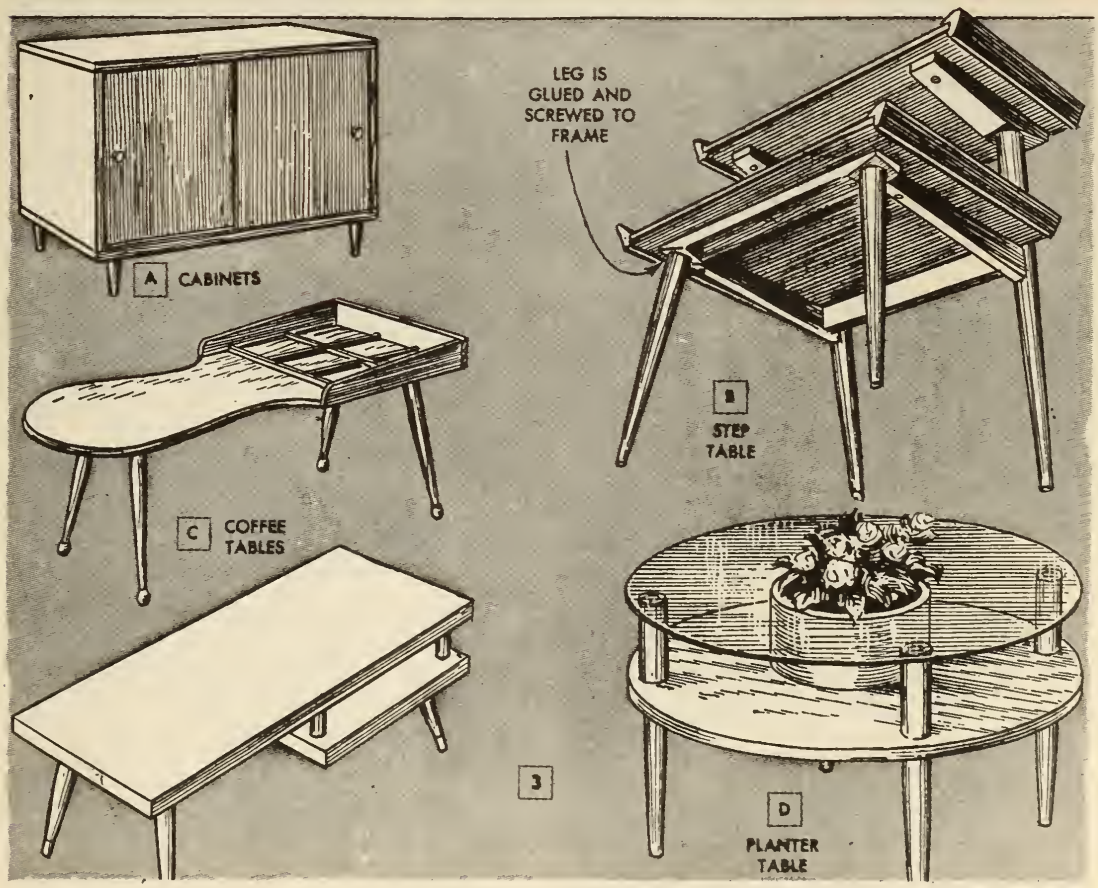
Hi Sibley, Nuevo, Calif.

1



2 LEG STYLES

PLAIN TAPERED TURNINGS



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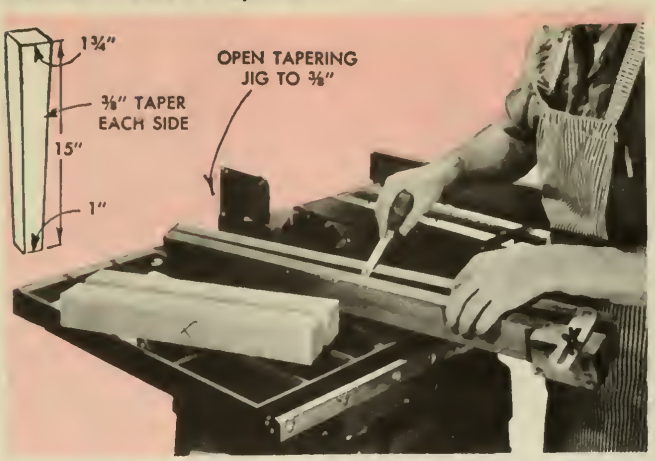
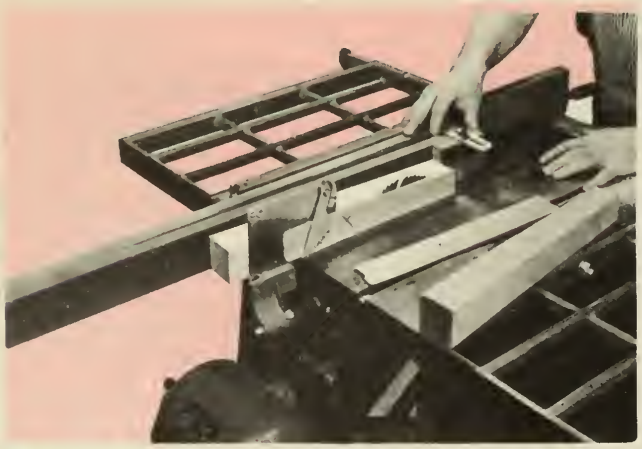


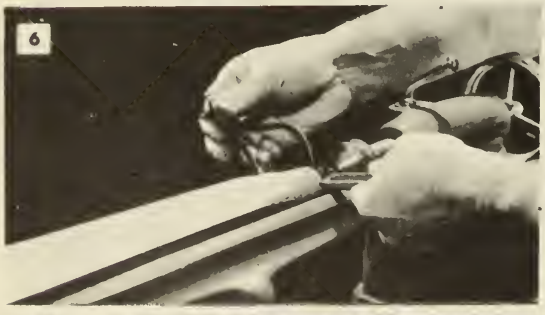
You can save a lot of lathe time by tapering the square from which turning is to be made. This is done as in photos above and below, using a tapering jig. When making taper cuts, be sure to allow sufficient stock for rough-turning into round. Plain, straight tapers are turned as in Figs. 6 to 9 inclusive

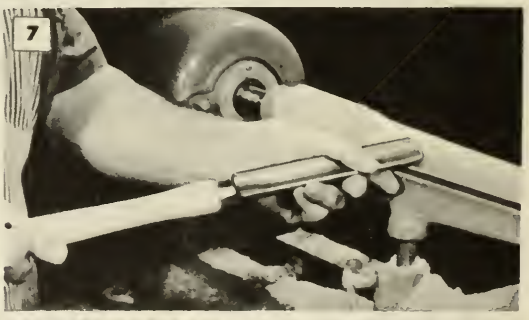


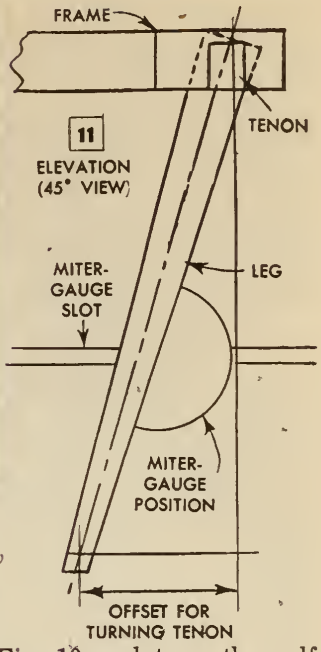
MODERN DESIGN helps to reduce waste of material by the use of plain tapered turnings for cabinet, bench and table legs. Although there are allowable variations in styling, the plain turning has none of the intricate bead-and-cove combinations which are basic design features of earlier "spool" turnings.

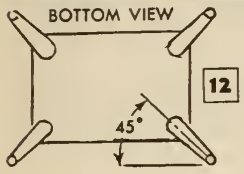
The six styles detailed in Fig. 2 are those in common usage in modern furniture construction. Several applications are shown in Fig. 3, details A to D inclusive. The step table, B, in Fig. 3, is pictured in Fig. 1. In any case, the hand-turning job begins with the square and you can save a lot of time and shavings if the taper is first ripped on the four sides of the square with a tapering jig as in Fig. 4. Set to the dimension required for the first two cuts on opposite sides of the square, then rip as in Fig. 5. Reset the jig to twice the first dimension and make the two final cuts. When determining the taper to be used, be sure to provide sufficient stock to allow for turning into round so that you end up with the leg size required.

Where there are no offset tenons or shoulders to cut in, turning the plain taper is a simple between-centers job in the wood lathe. Make sizing cuts at both ends with a parting tool as in Fig. 6, then rough-turn into









Turning a round tenon on a splayed leg is easy to work in lathe by offsetting as pictured above. By making a full-size drawing of that shown at right you can take off all measurements, also angle for trimming ends

round with the gouge as in Fig. 7. Finish with the skew chisel as in Fig. 8, and there you are. When finished work comes down to a small diameter in proportion to length, it may tend to vibrate under the turning tool when making cuts midway between the lathe centers. When this happens, some turners finish with a block plane as in Fig. 9. The plane must be razor-sharp and set to take a very light cut. In use the plane is held at an angle as pictured. This position gives a clean, shearing cut with the stroke of the plane made toward the tail center.

Where the frame, or base, of the project can be bevel-cut to take the upper end of the leg, the latter can be cut square across for fastening with a screw and glue. Or the leg can be turned with a concentric tenon. But in some cases the nature of the assembly will require the self-tenon to be turned by offsetting at an angle as in Figs. 10 and 11. To obtain accurate offset and angle it is helpful to draw a full-size elevation of the leg joint, Fig. 11. Then make the lathe setup in Fig. 10 and turn the self-tenon to the required size. Use calipers to assure a perfect fit as the degree of support afforded by the splayed leg is entirely dependent on an accurate fit of this joint, especially when no stretchers are used.

When metal ferrules are used, Fig. 2, care must be taken when turning the shoulder to obtain a precise fit, as otherwise a slight shrinkage of the wood will cause the ferrule to loosen. When locating splayed legs, with or without ferrules, be sure to place each one in the 45-deg. position in relation to the frame or base on which they are mounted, Fig. 12. If the upper ends of the legs are tenoned, either straight or offset, it is important to make sure that the tenon is cut to the right length, which is slightly less than the depth of the hole into which it is to be glued. When it is necessary to trim both ends of each leg, take the miter-gauge setting from the elevation drawing, then cut as in Figs. 13 and 14, shifting the miter gauge to the opposite groove in the saw table for the second cut. It is important to keep the same side of the turning up for both cuts. ★ ★ ★

Set miter gauge from a full-size detail made from Fig. 11. Then make first trimming cut as shown below

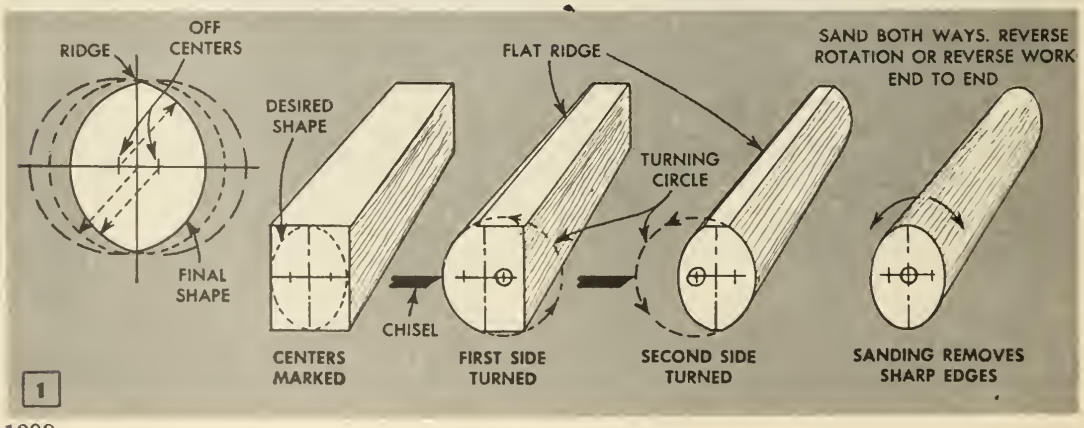
Move the gauge to the opposite groove in the saw table and make second cut. Keep work same side up

Off-Center TURNING

OFF-CENTER turning is a useful wood-lathe technique that makes it possible to turn tapers and ovals in a wide variety of shapes and sizes. The four splayed legs of the lamp table pictured above are examples of the practical application of spindle turning by the off-center method. The legs are of the club-foot, or spade-foot, type with a square top section and a swell, or barrel shape, at the center of the turned section. Some handwork is required to finish the spade foot, although the job is produced very nearly complete in the lathe as will be seen from the five stages of the work shown in Fig. 8. Turning procedures for both taper and barrel shapes are pictured in Figs. 4 to 11 inclusive.

Oval turning: The oval spindle is the basic form of off-center turning. A hammer handle is a good example. To work a turning to finished size, make a simple layout as in the left-hand detail, Fig. 1. This will enable you to locate both the true centers and the off-centers on the ends of the stock. Before mounting between lathe centers, be sure that the material is large enough to include the long diameter of the oval. When the work is to be offset at both ends and turned to the oval shape throughout the length, off-centering is done on the square.

With the centers laid out, mount the stock on the true centers and turn into round. Then mount on the first pair of off-centers ready for turning the first side. If the round is more than 1¼ in. in diameter, reduce the lathe speed to about 500 r.p.m., or less. Turn only with scraping tools such as the spearpoint and roundnosed chisels. The gouge and skew chisels, which are cutting tools, tend to run too deeply on the interrupted cut. After the work has been turned into round, some wood turners pencil a ridge line on the work as in Fig. 2.

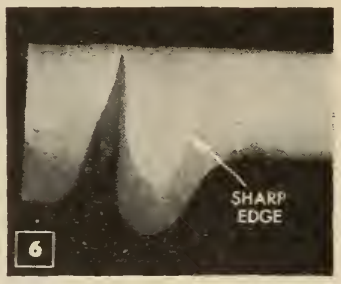


After turning work into round, mark ridge line the full length of turning. Turn offset side to line

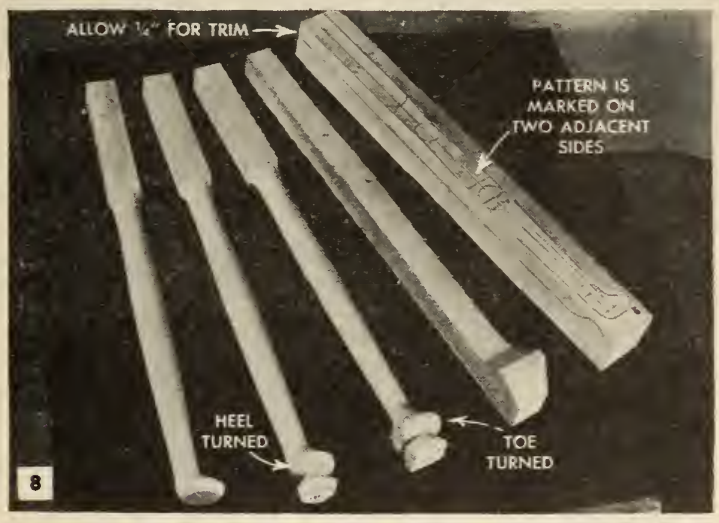
Locate the offset centers from the two flat sides of work. Here the offsets are made on the diagonal

Body of turning and front of foot are turned down on true center

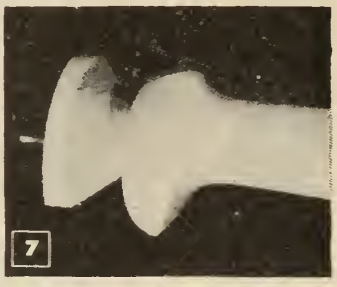
Toe is not a full circle and it must be measured from the flat side



Work is off-centered at lower end only to turn heel of foot

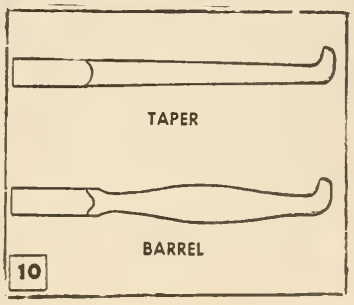


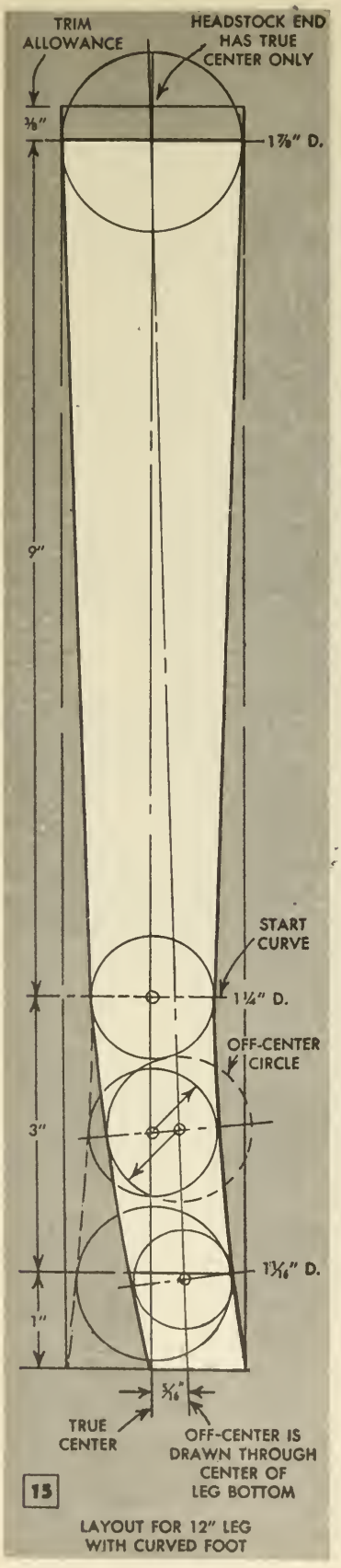
First step in turning the spade, or club, foot is to mark the pattern on two adjacent sides of the turning square. Then saw to rough shape



Light filing and sanding are necessary to remove sharp edges and shape foot to the required contour. Waste piece is sawed off

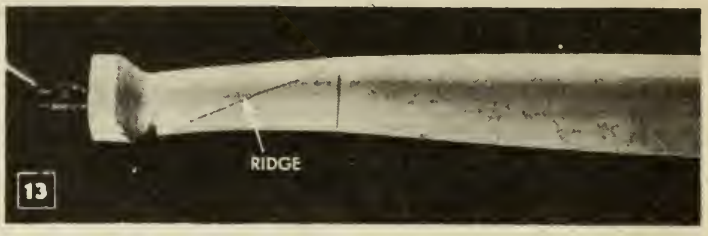
Careful sanding smooths the foot ready for finishing in color desired



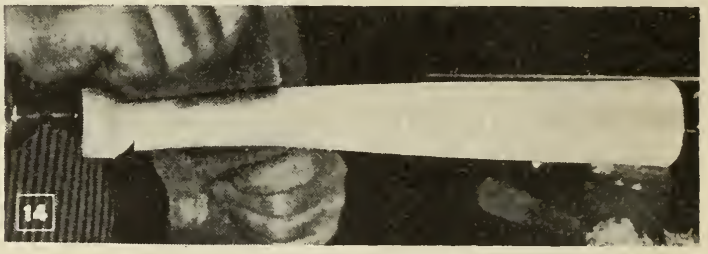


LAYOUT FOR 12" LEG WITH CURVED FOOT

First step in making curved foot is turning into round on true center



Work is then off-centered at one end to turn heel of curved foot. Second step forms a sharp ridge at approximately point indicated



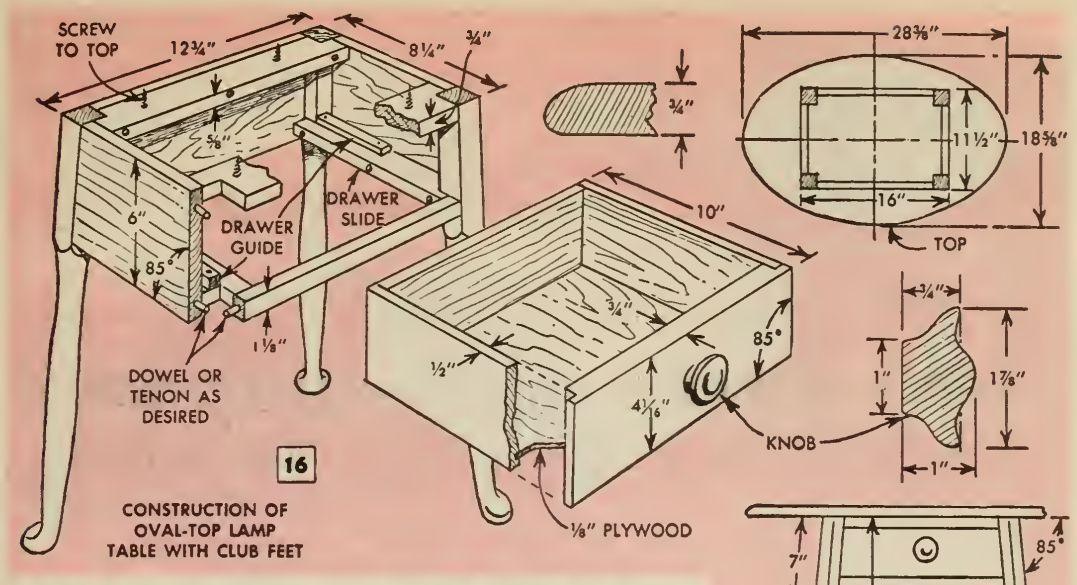
In the final step, ridges are removed by sanding and filing to contour

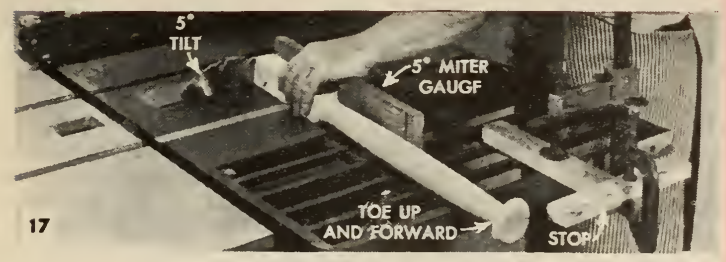
When off-centered, the stock forms a double image as it rotates, making it fairly easy to determine the correct contour by eye alone. After the first cut is finished to the ridge line, shift the stock to the second pair of off-centers and work the second cut to the ridge line. Then finish the sharp ridges by sanding the work while mounted on the true centers.

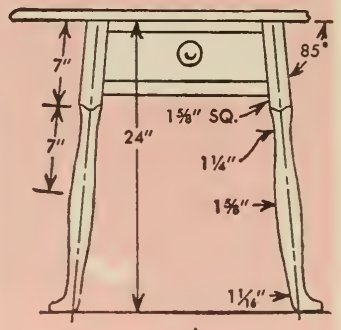
Usually it is better to work a long oval on rectangular, rather than square stock. This saves both material and time. Instead of running the ridge down to a sharp line, it is left as a narrow flat which is easily sanded out to a smooth curve. However, in smoothing the work while rotating in the lathe, the sandpaper tends to cut faster on the leading edge. This often makes it necessary to shift the work end-for-end to obtain a true contour.

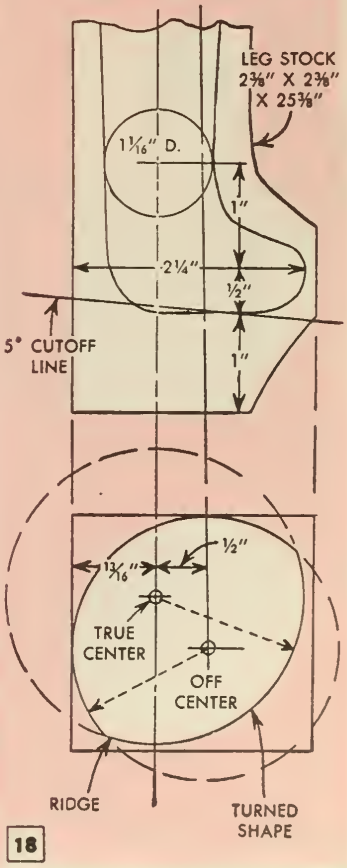
Spade foot: The spade foot, or club foot, is turned by off-centering at the tailstock end only. If the top is to be a square section, as in the lamp table, Figs. 16, 17 and 18, off-centering must be done on the diagonal, Fig. 3. Just as in turning a plain oval shape, the desired contour is determined by making a layout of the arcs with a compass. Off-centering ½ in. is a good average for this type of work. When making splayed legs be sure to make an allowance for trimming at the top end, Figs. 8 and 17. Also in sanding, Fig. 9, it is helpful to recenter the work between the two previous centers.

Curved foot: This is very similar to the spade foot, except for the variation in the shape of the work. In making the layout the diameter at the bottom end should be held to the same dimension as the straight taper. The amount the bottom end is turned out determines the off-





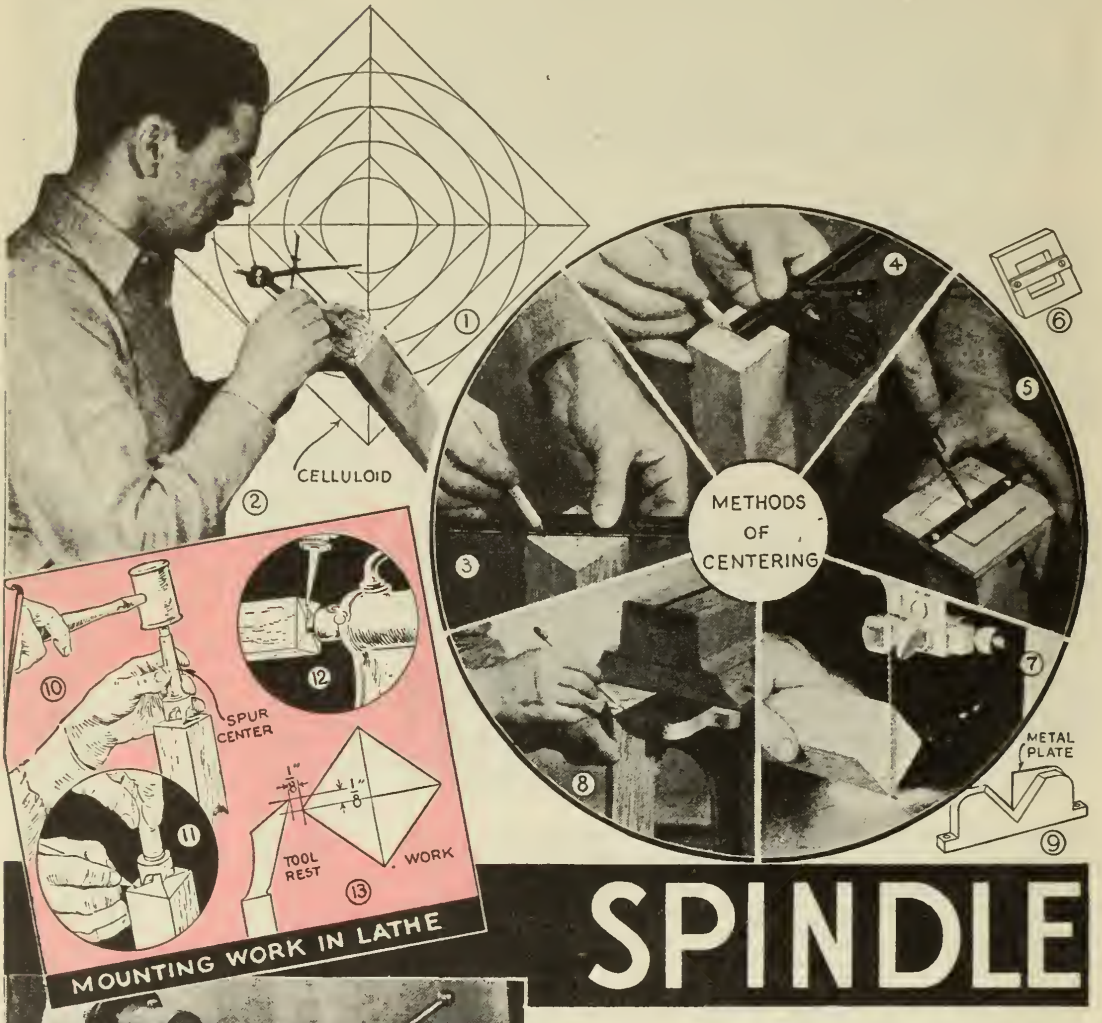




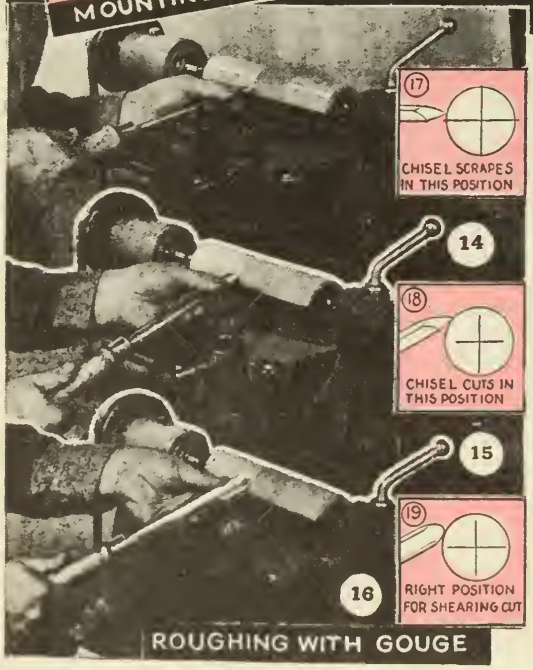
set, as the off-center line must pass through the center of the stock, Fig. 15. Off-centering between ¼ and ⅜ in. is common in this type of turning, with ⁵⁄₁₆ in. a good average. Figs. 12 to 14 inclusive show the progress of the work. After turning the heel to contour, the ridges, Fig. 13, should be cut down with a file to obtain a circular shape. Sanding in the off-center position, Fig. 14, will smooth the contour. When assembled in a stool or other suitable project, these legs have the same appearance as those which are steam-bent.

The shape at the center of the curved leg can be made more circular by off-centering the headstock end, drawing the off-center line through the centers of the turning circles at the bottom and top of the curved portion, Fig. 15. It should be noted again that if the turning is to be made with a round top end, off-centering can be done on the square. If the top end is a square section, off-centering must be done on the diagonal, as with the spade-foot leg.

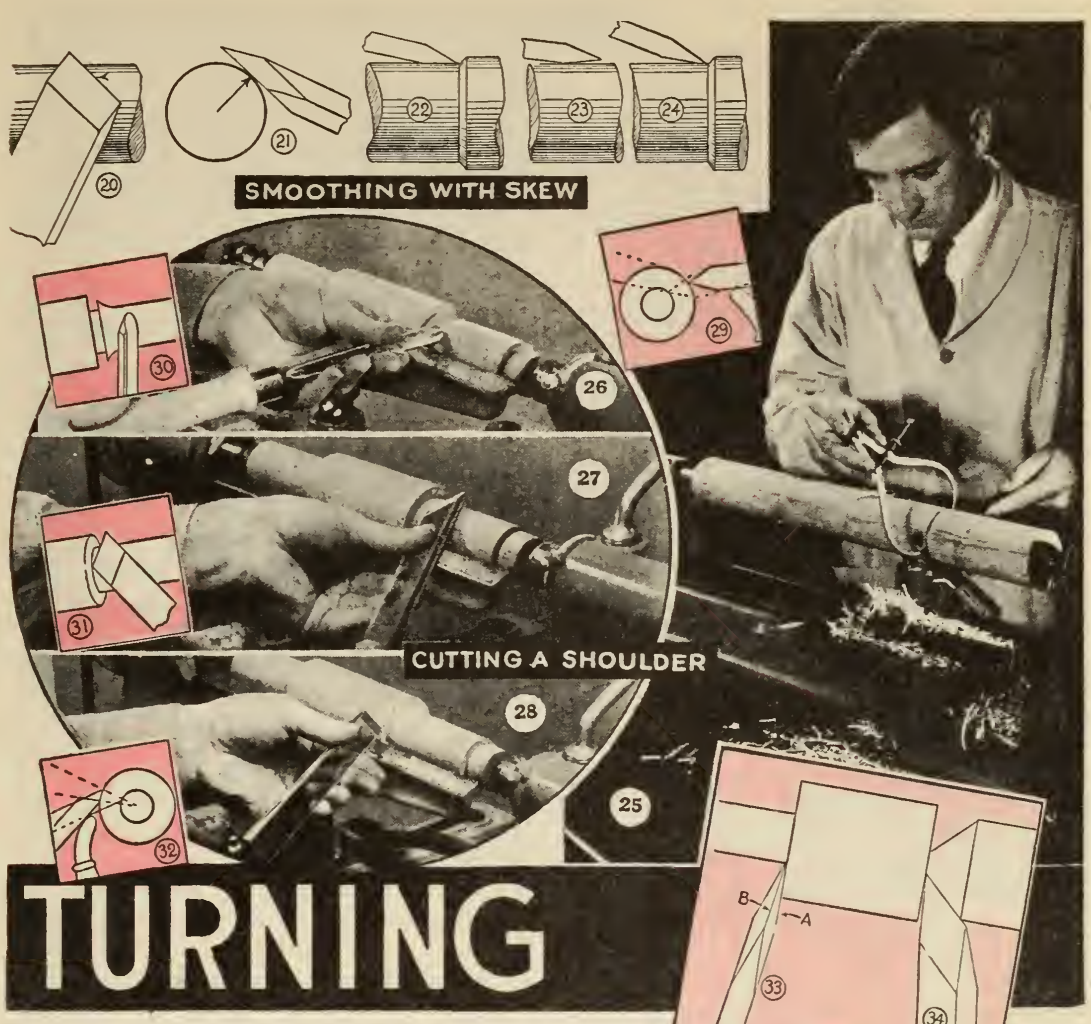
Typical project: With slight alterations the table pictured on page 1292 and detailed in Figs. 16 and 18 is suitable for either the splayed spade-foot leg or the curved leg. The spade-foot, or club-foot, type of leg appears at its best when splayed as indicated in the detail. However, the curved leg also can be used simply by squaring the oval table top (it can be either square or rectangular) and squaring the ends of the rails so that the legs stand vertically when the table frame is assembled. If mortise-and-tenon construction is used in joining legs to the rails, the mortises should be cut before the legs are turned. Ordinarily, it's a good idea to carry out all rough sanding while the work still is mounted in the lathe. ★ ★ ★



SPINDLE

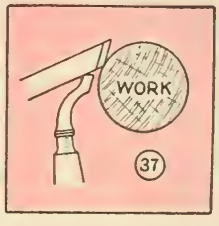


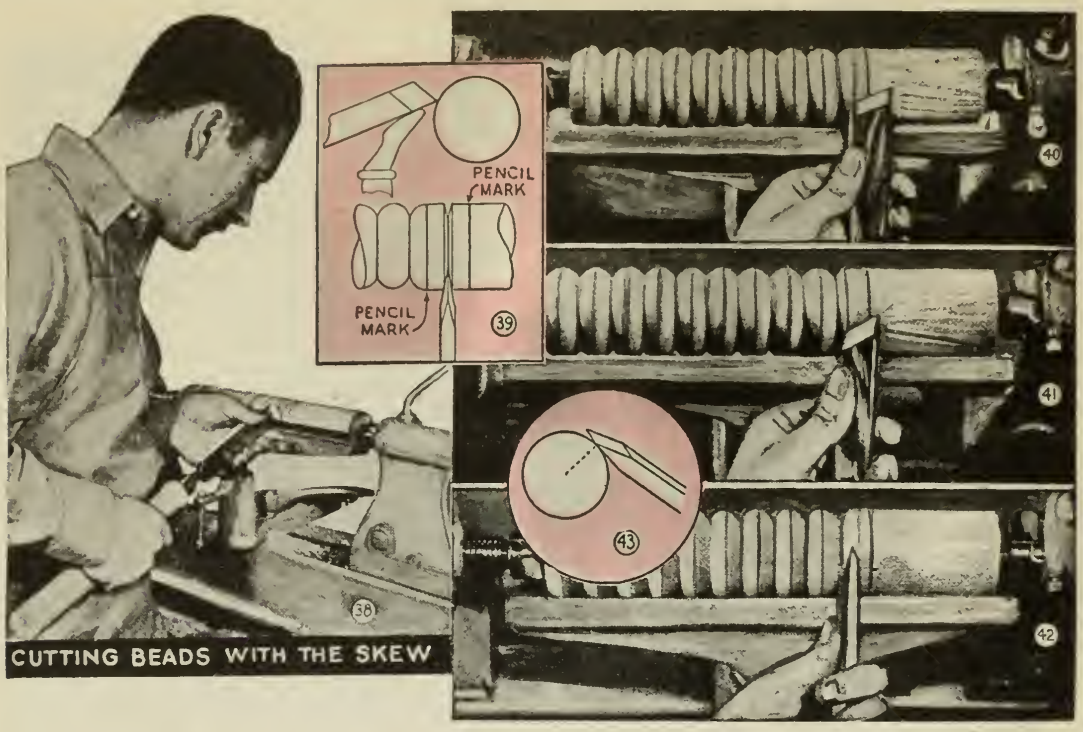
SPINDLE turning between centers is the groundwork for all wood lathe operations. The first step in making a spindle turning is centering the stock. The latter should be square, or nearly so, and the center at either end located and marked by any of the methods shown in Figs. 1 to 9 inclusive. After centering, the spur center is driven into one end of the work with a mallet, as shown in Fig. 10. Never drive the work onto the spur center in the lathe. Since the spurs of the center may not be exactly alike, nick one of them with a file and make a pencil mark opposite the nicked spur as in Fig. 11. Thus marked, the work may be removed from the lathe at any time and accurately re-centered when it is again mounted for turning. Mounting the work between centers is done by advancing the tailstock cup center



into the work while the latter is being turned by hand. When the stock binds, the tailstock is backed off about one-quarter turn and locked. Apply a few drops of oil, as in Fig. 12, to prevent the wood from burning the cup center. Many turners use tallow or wax for lubricant, since this does not stain the wood. Fig. 13 shows the relative position of the tool rest with the axis of the work. As the square is turned into round, the rest is moved up by stages. About ⅛ in. above the axis and the same distance from the surface, is a fair rule to follow, although there are variations, of course.

The first turning operation is the "roughing cut," made with the gouge. Figs. 16 and 19 show the proper position—the bevel should be tangent to the work, and the tool rolled on its side. Figs. 14 and 17 show the wrong position, resulting in a scraping action. The position shown in Figs. 15 and 18 permits the chisel to cut, but lack





CUTTING BEADS WITH THE SKEW

of clearance prevents the easy, shearing cut possible with the correct position, Fig. 16. The final smoothing of the cylinder after roughing is done with the large skew chisel, the correct position being shown in Fig. 20, with the cut moving toward the right. By reversing the position of the chisel, the cut can be carried equally well to the left. The edge of the chisel should be tangent to the work, Fig. 21, and should contact the surface at the point indicated. The secret of successful smoothing with the skew lies in using the bevel of the chisel as a fulcrum, Fig. 22. If the handle is too low, the edge will not cut, Fig. 23, while if the handle is too high, Fig. 24, the edge will not be supported and will have a tendency to draw into the wood.

Next, the various diameters of the turning are set off with the parting tool, Fig. 25. The calipers are set slightly oversize, and are held against the revolving work until they slip over the stock remaining at the bottom of the groove. This is a scraping cut, which is the safest. A better action is obtained if the lower edge of the chisel is kept approximately tangent to the cylinder, Fig. 29, but the tool is a bit more tricky to handle.

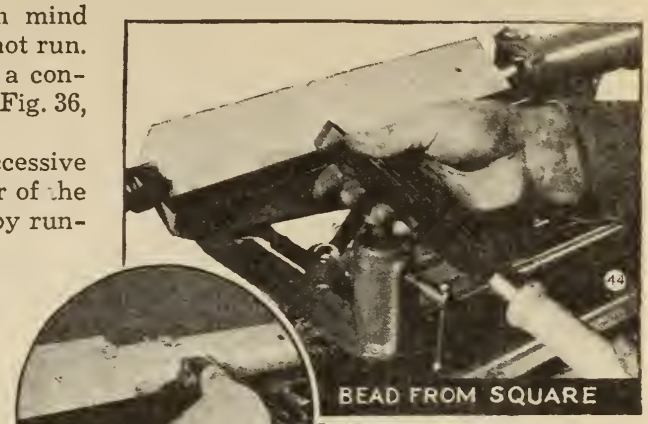
Following the parting tool, Figs. 26, 27, and 28 picture the cutting of a shoulder. In the first operation, the waste is cleared away with the gouge, Figs. 26 and 30. The heel of the skew is then used to smooth the new surface squarely into the shoulder, Figs. 27 and 31, while the toe of the skew is used to dress the shoulder smooth and to exact size, Figs. 28 and 32. When using the skew in this last position, the cutting edge should at all times point toward the center of the work, Fig. 32. A still more important point in making this cut is shown in Fig. 33. Here the line "B" is the cutting edge of the chisel; line "A" is the bevel. Notice particularly that the bevel A is exactly parallel with the cut surface, while the cutting edge is slightly turned away. The same general technique used in cutting a shoulder can be used for clearance cuts or for making vee grooves, as in Fig. 34. Vee grooves can also be made with the heel of the skew, as in Fig. 37. From this position, the handle of the chisel is raised to hinge the cutting edge into the wood. The same rule about not engaging the full cutting edge applies. Slightly exaggerated, Fig. 35 shows how the edge of the chisel is almost, but not quite, parallel with the surface being cut. This is correct. Fig. 36 shows the edge of the chisel exactly parallel with the cut surface, which is incorrect. When the edge is thus engaged, a

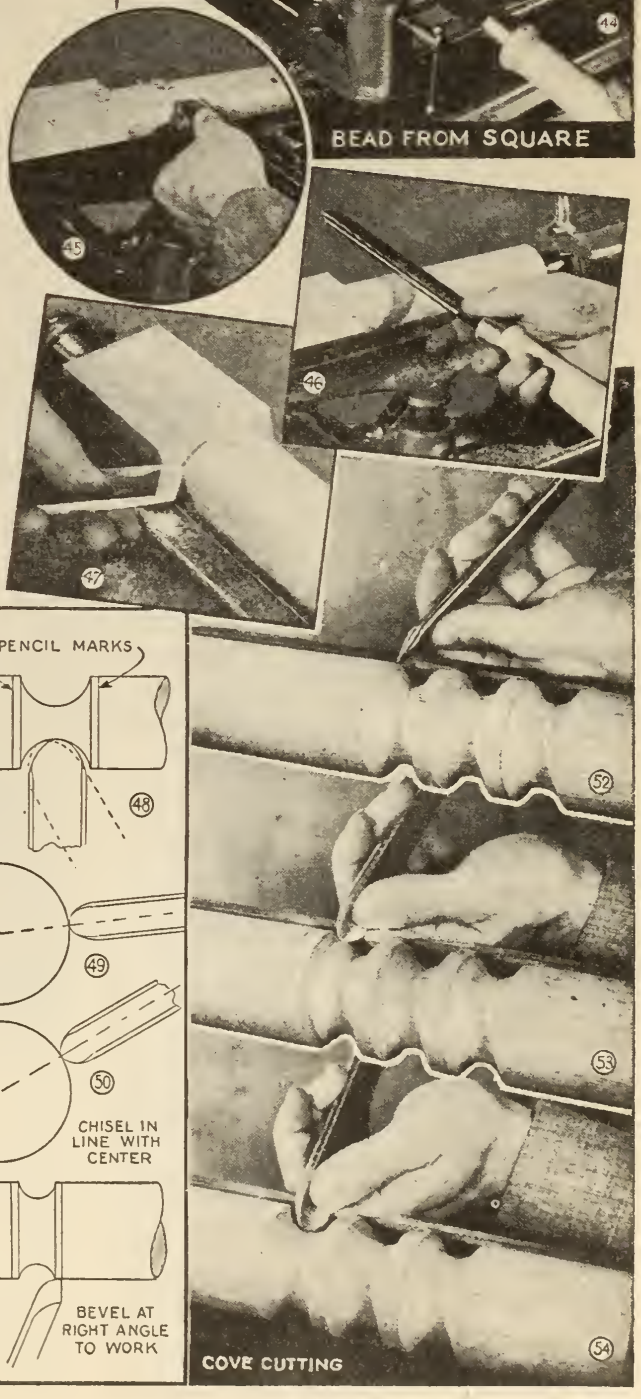
"run" invariably results. Keep in mind that a point, either toe or heel, cannot run. It is only when the whole edge or a considerable part of it is engaged, as in Fig. 36, that runs occur.

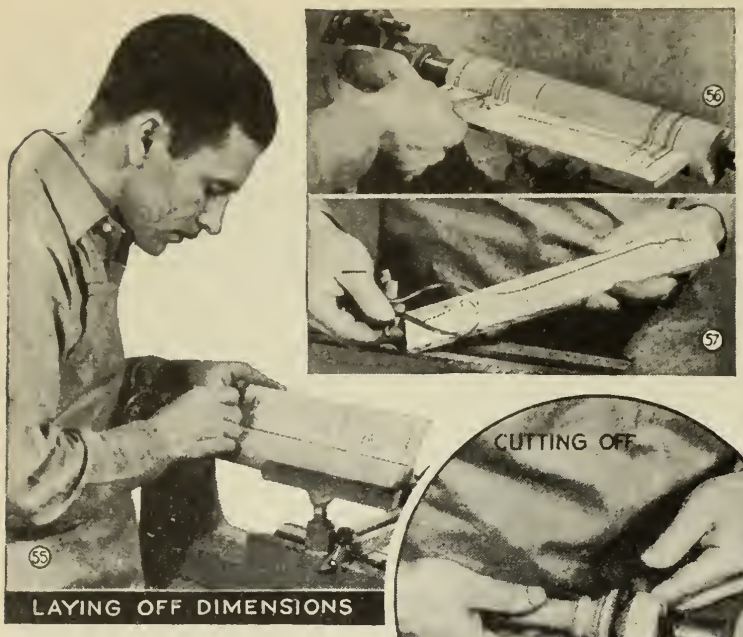
Figs. 38 to 42 inclusive show successive stages in cutting a bead. The center of the depression should be marked first by running in with the toe of the skew, as shown in Figs. 38 and 39. Starting the cut from the position shown in Fig. 40, the chisel is slowly rolled to the left and simultaneously the handle is raised to keep the bevel in contact with the wood. The essential point in cutting a bead is shown in Fig. 43—the bevel of the chisel should be tangent to the work. In this position, the chisel cannot run.

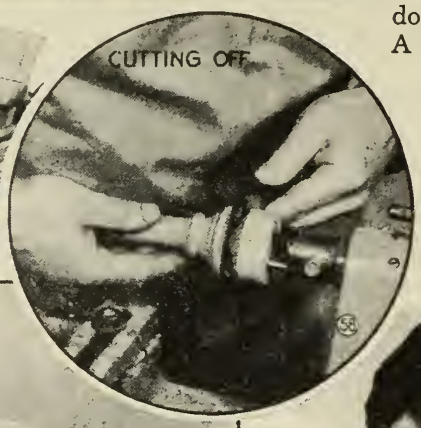
Quite often, a bead must be cut from a square portion of the turning. When this is done, the work is first nicked with the point of the skew, Fig. 44. After nicking, the round portion of the turning can be roughed out without any danger of splintering the square part, Fig. 45. After the round portion is turned down to a true cylinder—this is easily checked by placing the chisel flat on the revolving work to detect any "hammering" action, as shown in Fig. 46—the bead itself can be cut. This can be done in the same manner as previously described, although many turners prefer the simpler scraping operation with the toe of the skew, Fig. 47.

Figs. 51 and 52 show the start of the difficult cove cut, and Figs. 53 and 54 show the slight rolling action of the gouge as the cut progresses. Pencil marks are first made to indicate the edges of the cut, and the excess wood inside the marks is removed with the gouge, using a scraping position,









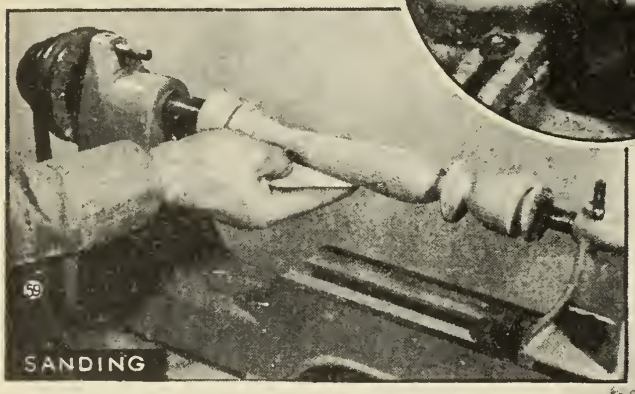
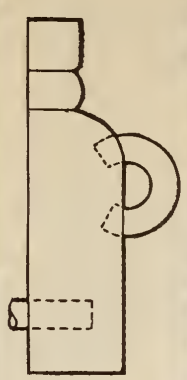
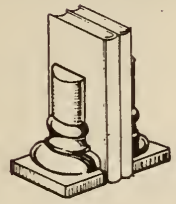


Fig. 48. The entire cut can, of course, be made in this manner, the practice being quite common even among experienced turners. To proceed with the rolling cut, the first essential point is that the gouge must point to the exact center of the work. Whether the tool rest is low, Fig. 49, or high, Fig. 50, this same rule applies. The reason for this is simple: The exact point of the gouge which is thus engaged cannot run. The second essential point is shown in Fig. 51—the bevel of the gouge must form an exact right angle to the surface of the work. From this position the gouge is rolled into the cove, making one-half of the cut in one operation, and the opposite side of the cut in a second operation which is a reverse of the first. It's important that the tool handle be swung through an arc simultaneously, so that the bevel will assume the same relative position throughout the operation.

When the basic cuts have been mastered the turner can do any ordinary spindle turning. The essential points are illustrated in Figs. 55 to 60 inclusive. The first step after smoothing the cylinder is to mark off the dimensions. This is best done with a layout board. A layout board is simply a thin piece of wood on which is drawn a full-size half section of the proposed turning. Placing the board against the cylinder, the turner can quickly mark the various points along the turning, as in Fig. 55. Many turners place the board flat on the tool rest, Fig. 56, and mark the work while it is revolving. After marking the required lengths, the diameters are picked off, as shown in Fig. 57, and the caliper setting is then used in making the initial parting-tool cuts, and then the various forming cuts are made.



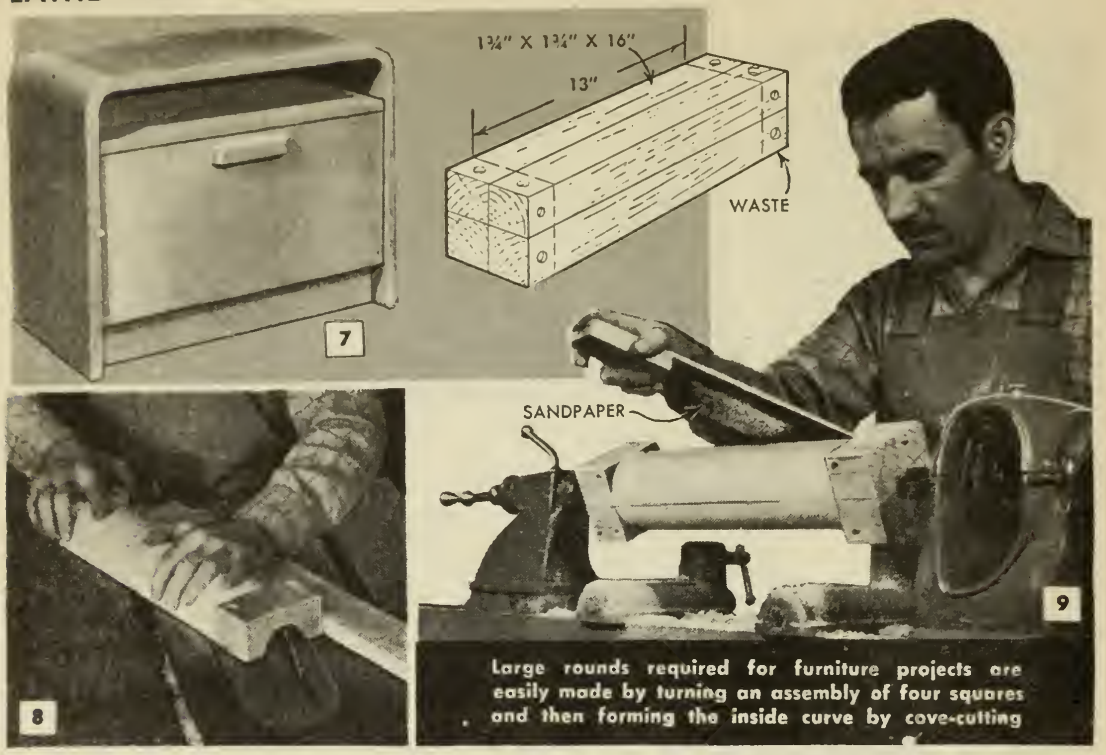


TWO AND FOUR-WAY SPLIT TURNINGS

By Sam Brown

SINCE THE EARLIEST DAYS of the colonial cabinetmakers, split turnings have found a place in the design ornamentation of home furnishings. Two and four-way splits of spindle and faceplate turnings are perhaps the most commonly used, although other divisions of the spindle and faceplate turning are often useful. In some cases the halves of a four-way split are coped to form segments which are fitted to sides and tops to form radius, or "waterfall," corners. Fig. 7 is an example of this application in modern design. Other examples of the application of the split turning are pictured in Figs. 1, 2, 3 and 10.

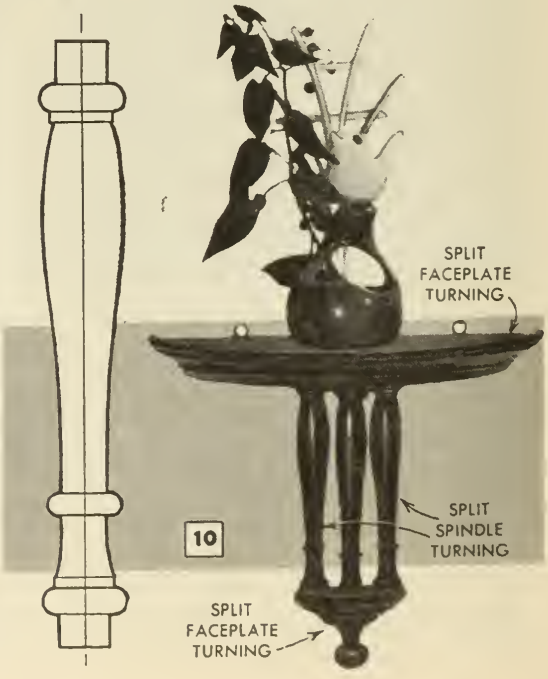
The brown-jug coaster set, Fig. 1, is a typical two-way split with the handle added to complete the design. Broken-column book ends, made as in the sketch below Fig. 1, also are typical of many novelty projects where the splits can be used in pairs. Fig. 2 pictures another application where the one split is a minor terminal feature of the design. Such units usually are made in pairs. An example of the four-way split is pictured in Fig. 3. The four-way turning provides the four legs of the lamp table. The spindle turning is assembled as in Fig. 7, the detail, and is turned and finished as in Fig. 9, the work being mounted between centers and turned with a slight taper. When the built-up turning is disassembled and the waste removed you have four legs of uniform size and taper. Other examples of the four-way split turning are shown in Fig. 11, details A to E inclusive, and also in Fig. 12, the upper details. The latter show typical assemblies made with split turnings A and E in Fig. 11. When preparing a split turning for a cope cut,

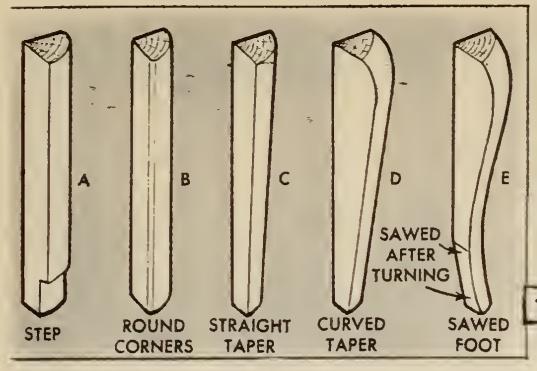


Large rounds required for furniture projects are easily made by turning an assembly of four squares and then forming the inside curve by cove-cutting

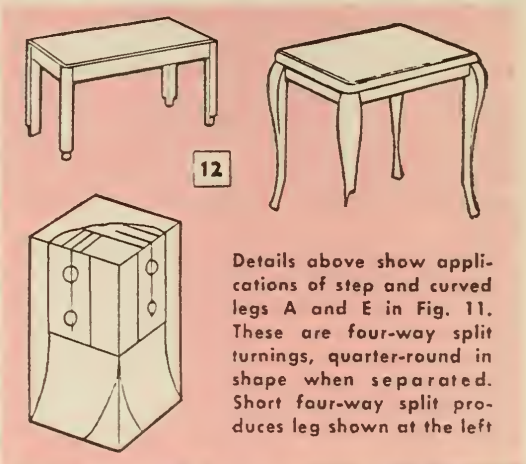
Fig. 8, be sure to locate the screws in the waste at the ends so that they will clear the saw blade when the cope cut is made to the desired depth.

There are several methods of assembling the stock for two-way and four-way split turnings. One of the most common is pictured in Fig. 4. The two pieces of stock are selected, ripped to width and the meeting faces are planed true. The over-all length of the pieces exceeds the finish length of the turning by at least 1½ in., allowing ¾ in. of waste at each end. The thickness and width of each piece should exceed the required radius of the turning by at least 1/16 in., or better, ⅛ in. Then screws are driven into the ends outside the dimension lines as in Fig. 4. When the turning has been finished and sanded, Fig. 5, the waste ends are cut off, giving you the two splits, or halves, as in Fig. 6. This method is quite satisfactory for comparatively short turnings up to 12 in. in length and a small finished diameter of ½ in. or more. However, for longer turnings the method has one pronounced disadvantage. When fastened only at the ends and not along the length, the halves tend to whip and separate at the higher lathe speeds, especially as the turning nears final form in the small and large diameters. This causes the trailing edges of each of the halves to splinter as they pass the cutting tool. In some applications this defect may not be objectionable, but in most cases the edges of the split turnings are exposed and any irregularity is difficult to conceal in ordinary finishing procedure. Because of this possibility, experienced craftsmen generally glue the strips together with a thickness of heavy paper between. A glue joint made in this way will be sufficiently strong to prevent whipping of the two halves of the turning, even at fairly high lathe speeds, and the two members are easily pried apart





Some machine operations can be done on four-way splits after separation, but as a rule it's best to do this preliminary work while job is still in square

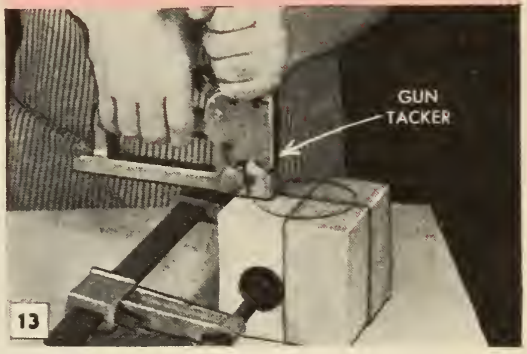


Details above show applications of step and curved legs A and E in Fig. 11. These are four-way split turnings, quarter-round in shape when separated. Short four-way split produces leg shown at the left

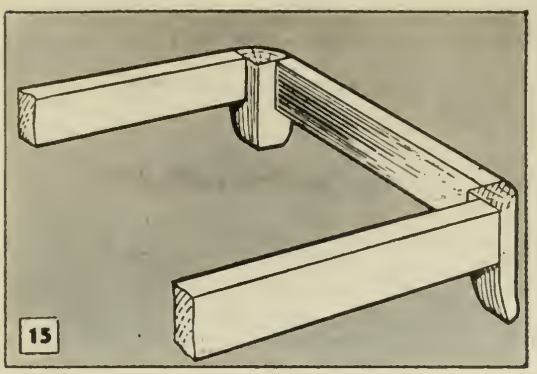
when the turning is finished. Another method of joining two or four members when the finished turning is short is pictured in Figs. 13 and 14. The pieces are clamped together as in Fig. 13 and joined with staples driven by a gun-type tacker, the staples being driven across the joints as shown in Fig. 14 in such a position that they do not interfere with the lathe centers. This method is especially effective when joining pieces to make short legs of the type shown in the lower detail, Fig. 12, also in Figs. 15, 16 and 17. In this case, the outer contours of the legs are finished by turning and the inner curves are bandsawed as indicated on the details and photo, Fig. 17. Where curved legs are to be joined to rails by doweling or mortise-and-tenon joints, it generally is best to cut the mortises or bore the holes for dowels before the members are joined for turning. This procedure provides four working surfaces for these preliminary operations. For some operations two adjacent working faces will suffice, as in the photo, Fig. 11. In this case, supplementary machine operations can be carried out after turning.

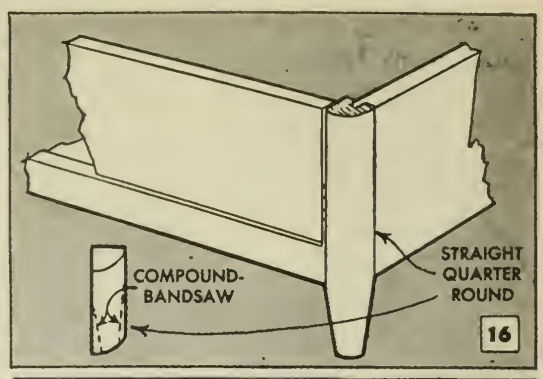
When mounting either the two-way or four-way split turning in the lathe, special care should be taken in centering. If the center is offset, even slightly, the turnings will be of unequal size. As a rule it's best to drill a small pilot hole in the end grain to take the point of the lathe center. If the center is driven into the wood without first drilling a pilot hole there is the possibility that the point may follow the grain. This tendency could throw it off as much as ⅛ in. or perhaps even more in some woods. On small-diameter turnings this much offset could result in a noticeable variation in the size of the splits. In centering, always mark diagonals from the four corners and then drill the pilot hole on the intersection of the lines.

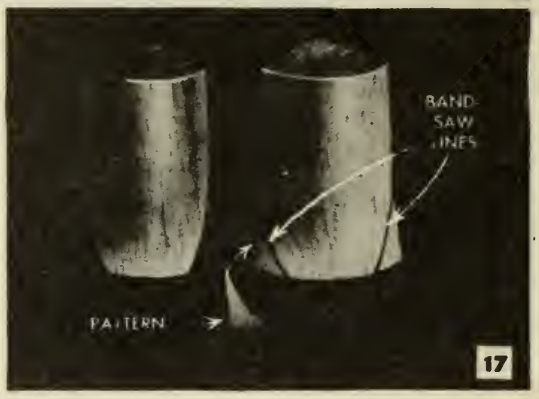
When working large turnings, such as that pictured in Fig. 9, always use the slowest speed of the lathe until the work is turned into round, or very nearly so. On straight turnings and those with long,



Photos above and below picture method of joining and turning short stock to produce legs of the type shown in Figs. 12, 15 and 17. Note use of gun tacker

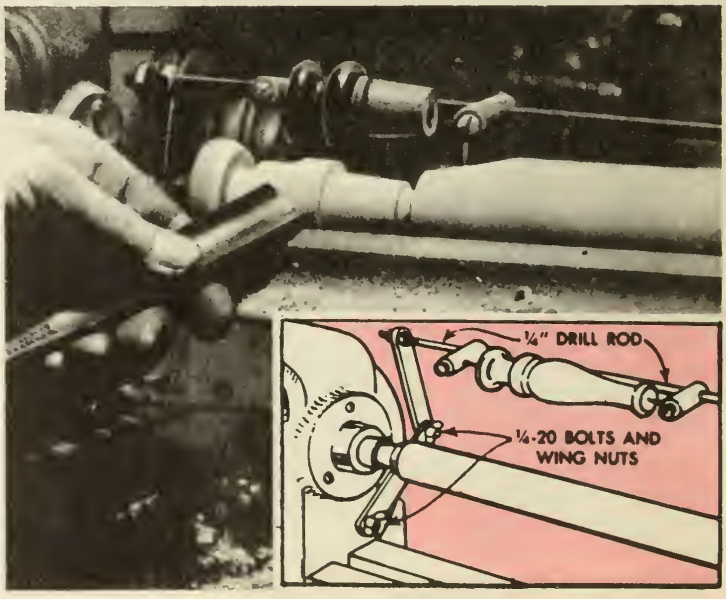






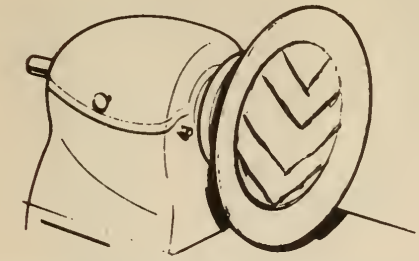
sweeping curves, use the gouge for roughing and the skew chisel for the finishing cuts. These tools give a shearing cut with very little tendency to chip the stock at the trailing edges. Avoid use of the scraping tools such as the round and square-nosed chisels and the parting tool, except where necessary to produce the form desired. Keep the tools razor-sharp by frequent honing on a fine oilstone or a leather strop.

Select straight-grained stock for making split turnings of either hardwood or softwood. Avoid cross or oblique graining and never attempt to assemble stock for split turnings from pieces containing encased (loose) knots. Nearly all hardwoods and softwoods are suitable, except possibly those having a coarse, open grain which may cause some trouble by chipping at the trailing edges. However, should the edges chip lightly it is possible to remove this by running the parts over a jointer, one pass usually being sufficient to remove any irregularity at the edges. ★ ★ ★



IF EXTREME ACCURACY is not necessary, time can be saved when turning a duplicate part on a wood lathe by holding a pattern close to the turning blank. A holder for the pattern consists of a length of ¼-in. drill rod, threaded on one end and fastened to a flat-steel arm that pivots on a second arm which is mounted on the headstock casting. Two adjustable brass rods with a phonograph needle fitted near the end of each hold the pattern in position

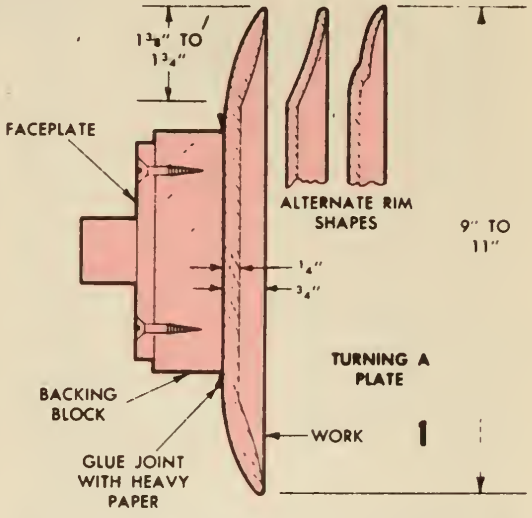
FACEPLATE TURNING



By Sam Brown

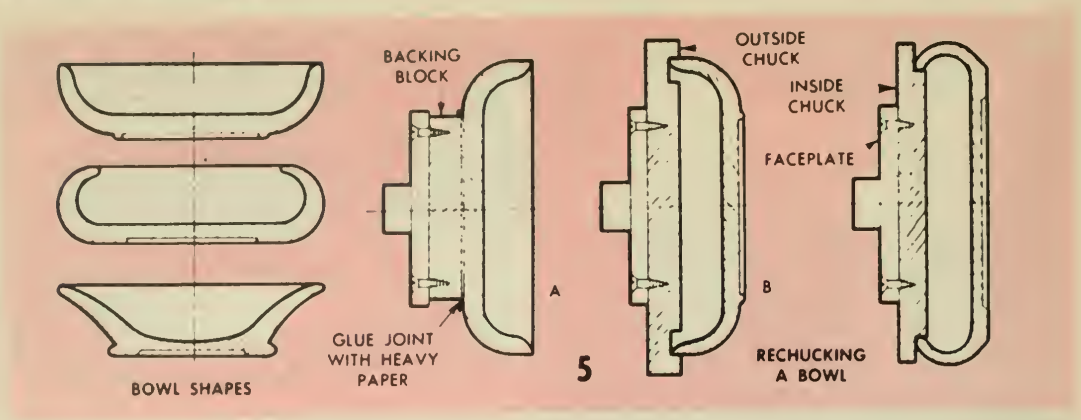
NO FORM OF wood turning gives as much enjoyment and satisfaction as the turning of a cylindrical box, bowl or platter in select cabinet woods. Projects of this kind take two to four hours to complete from start to finish, and require little skill — only a little muscle and patience. Hard, white maple is the recommended first choice in readily-obtainable woods, and a single plate or platter about 11 in. in diameter is a good first project. Preferably the wood should be one piece, but stock with a single waterproof glue joint is satisfactory.

Work is mounted as shown in Fig. 1. The backing block is screw-fastened to the lathe faceplate and is turned on the outer face to form a true flat surface. The work stock is glued to the backing with



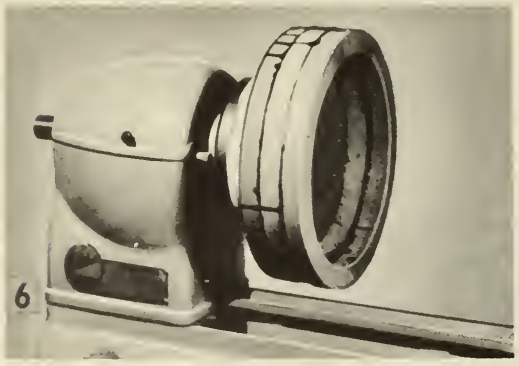
a disk of glazed paper at the joint. The slick paper used for magazine covers is excellent. Coat both sides of the paper disk with glue and then clamp the assembly with C-clamps. It also is practical to use the lathe itself for clamping by bringing up the tailstock to press against the wood.

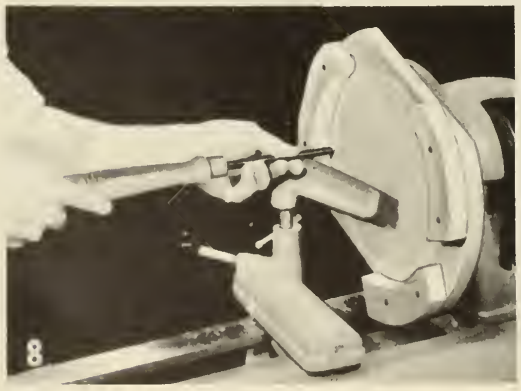
Turning is just a matter of scraping, using any chisel that fits the shape of the wood surface. The most important point is to keep chisels sharp—light honing every 10 or 15 min. is required for

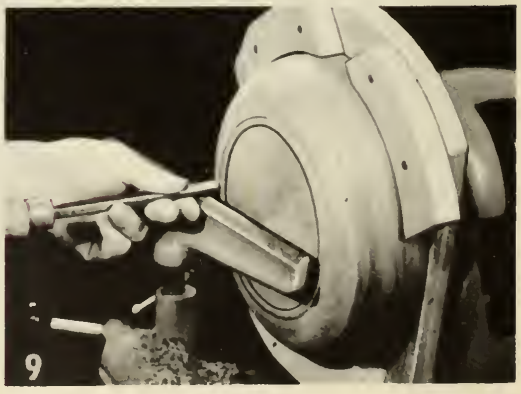


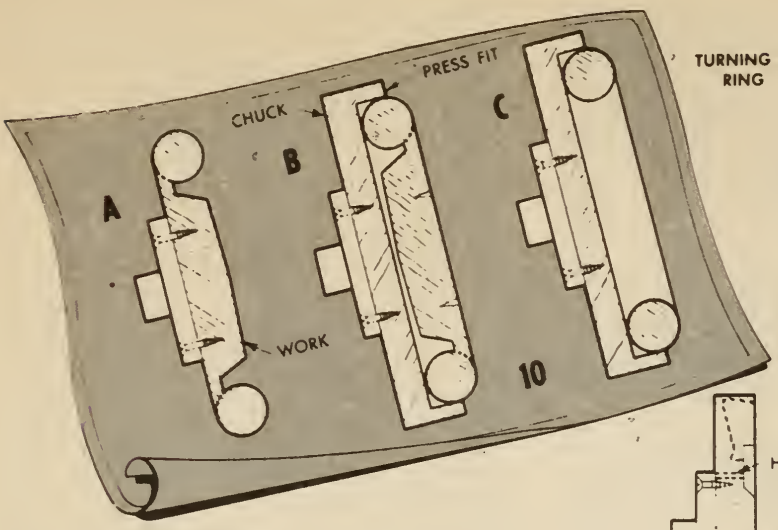
clean, fast cutting. A large gouge usually is used for roughing cuts, while lighter finishing cuts can be taken with a round-nose chisel. The main secret of chisel technique is to pick up a "bite" and hold it, moving the chisel slowly across the work. Very light cuts with flat or round-nose chisels are needed, Fig. 2, and at least 1/16 in. of wood must be removed in this manner to obtain smoothness in the two cross-grained areas present in every turning. Final sanding with 3/0 garnet abrasive will remove minor humps and hollows. The lathe should run at slowest speed, or about 600 r.p.m. for roughing, while second speed (about 1200 r.p.m.) can be used for finishing cuts and sanding, but only if you feel comfortable with the work turning at this higher speed. For a flat-bottom plate, all of the turning can be completed in one chucking. Fig. 3 shows the back being turned. After turning is completed, you can remove the plate from the back block by driving a sharp wood chisel into the papered glue joint. The glue itself will hold tightly to the wood—but the paper will split, as can be seen in Fig. 4. The flat bottom is finished by hand-scraping and sanding.

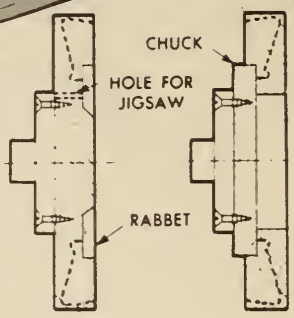
Sometimes you may wish to turn the bottom of a plate or bowl. In this case, the work must be rechucked. This is done by turning a disk of wood to form a recessed chuck into which the half-finished work can be press-fitted as indicated in Fig. 5. Details A, B and C show chucks for bowls of the three most common







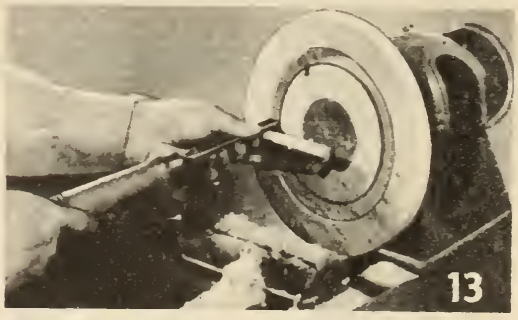




shapes. Wooden "jaws" nailed to a flat piece of plywood often are used, Fig. 8, instead of a one-piece solid chuck. Fig. 9 shows the bottom of the bowl being turned. Bowls always require thick wood. The needed thickness often is built up from thinner wood, always with an uneven number of layers, and usually with the grain running the same way in all pieces, Figs. 6 and 7. Rough stock for glue jointing need be surfaced only around the rim, a job which can be done by turning or with a planer head in the drill press.

Similar work operations are used in turning a ring or making a round, rabbeted frame, Figs. 10 to 14. Fig. 10 shows the steps in turning a ring. The first operation is done on a faceplate, detail A, after which the partly completed work is held in a wooden chuck, detail B, to complete removal of the waste stock, detail C. Steps in turning a rabbeted frame are given in Fig. 11, starting with a faceplate and finishing the frame on a special wooden chuck.

Often in plate and platter turning, the work will be too large to swing over the lathe bed and must then be worked on the outboard end of the headstock



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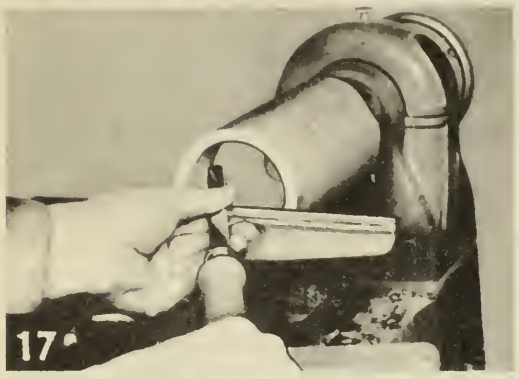
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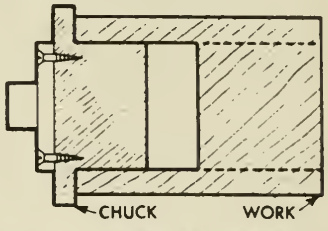
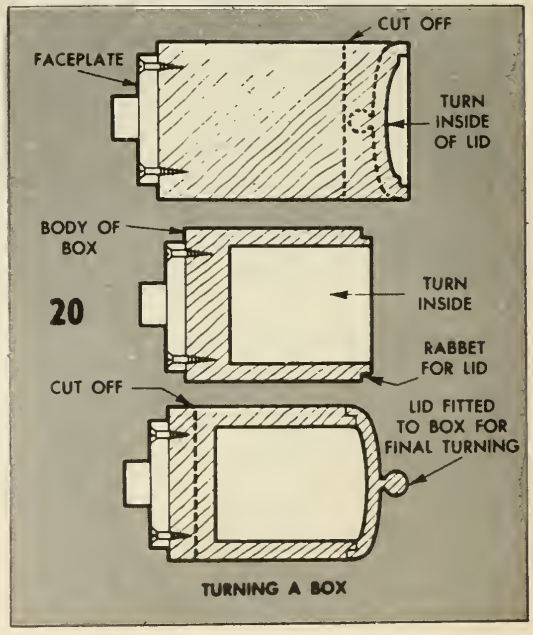
spindle with the aid of a floorstand tool rest, Fig. 15. If you don't have a floor stand, use a tool rest, or a wood or metal support, clamped to the table of a floor-model drill press as in Fig. 16.

When turning a cylinder-shaped box, the work itself provides a chuck for re-chucking the lid. Figs. 17 through 20 give the details. The lid often is worked on the same length of stock, but may be worked up from a separate length of wood if desired. A hollow cylinder is turned very much like a box but, if over 3 in. long, is usually rechucked to permit turning from the opposite end as shown in Figs. 18 and 19.

The fastest, easiest finish for faceplate projects is done with two coats of penetrating floor finish. This material is a phenolic resin and the finish is "in" the wood rather than on the surface. The finish is applied by brush or cloth, Fig. 21, and wiped clean in 15 to 20 min., no longer, and a second coat is similarly applied in about 8 hours, each coat being sanded down lightly and the final coat dulled by rubbing compound. For the more conventional "on the surface" finish, nothing beats three or four coats of water-white lacquer applied by spray. ★ ★ ★



TURNING A CYLINDER



TURNING A BOX

PLASTIC TURNING

IT'S FUN to turn plastics in either a metal or wood-turning lathe. Common craft plastics turn beautifully, the chip comes off clean in a long, paper-thin ribbon and the surface left by a sharp tool requires a minimum of final finishing operations. Turnings that involve curves, such as candlesticks and lamp bases, are best handled on a wood-turning lathe as the tool must be worked freehand. Turning straight, true cylinders or tapers is best done on a metal lathe where the position of the tool is fixed and the feed uniform. Turning characteristics of common plastics are similar to nonferrous metals and ordinary metal-turning operations can be duplicated on plastics. Nearly all plastics will take a fairly sharp knurl; they face off and shoulder perfectly and can be worked successfully with shaped cutters. With care you can run a clean, sharp thread.

General turning data is given in the table, Fig. 1, while Fig. 5 lists suitable lathe speeds and converts feet - per - minute (f.p.m.) to revolutions-per-minute (r.p.m.) for specific diameters. As an example of how these tables work out, suppose you are turning down a 1-in. spindle of the thermoplastic Tenite II, Fig. 1 shows the correct speed to be 300 f.p.m. and referring to Fig. 5 you will see that a surface speed of 300 f.p.m. on a 1-in. spindle requires a lathe speed of 1150 r.p.m. However, surface speeds ranging from 100 to 400 f.p.m. will work satisfactorily. Note from the table Fig. 1 that the phenolics (cast resins) require a high spindle speed and a slow tool feed, and that the reverse is generally true of the thermoplastics. The speed recommendations apply quite closely to all work under 2 in. in diameter, but on work over 2 in. in diameter the turning speeds for thermoplastics can be increased considerably because of the longer cooling cycle.

A good indication of the correctness of procedure is the shape and nature of the chip. If it gums and adheres to the point of the lathe tool, the speed is too high; if the chip tends to shatter or powder, the tool is dull or the feed is too fast. But with the correct adjustments and the proper feed you get a long, ribbon chip that curls away from the tool point without breaking, Fig. 6.

Much of the technique of turning plastics requires a careful study of methods of

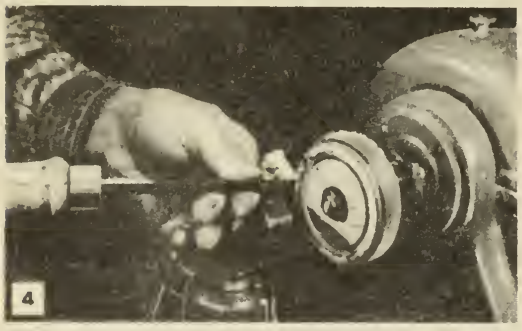
1 PLASTICS TURNING DATA

	TECHNICAL NAME OF PLASTIC	REPRESENTATIVE TRADE NAMES	FEET-PER-MIN. SPEED	FEED RATE (INCH PER REV.)	REMARKS
THERMO-SETTING	CAST PHENOLIC	CATALIN, MARBLETTE	400 OK 100 to 600	.004 or less	Slight odor. Turns easily with mild pressure. Cuts can be up to 1/8" deep. Heavy feed causes a powdery chip.
	LAMINATES	FORMICA, MICARTA	200 - 300	.004 or less	Very abrasive. Best turned with carbide tools. High-speed tool bits should have positive rake of about 15°
THERMOPLASTIC	CELLULOSE ACETATE	LUMARITH, TENITE I	300 OK 100 to 400	.007 or less	Sourish odor. Turns very easily with light pressure. Cuts can be up to 3/16" deep. Heavy feed causes excessive tearing. Both plastics in this group are practically identical in physical properties. Excellent for hand turning.
	CELLULOSE ACETATE BUTYRATE	TENITE II	300 OK 100 to 400	.007 or less	
	ACRYLIC	LUCITE, PLEXIGLAS	200 or less	.010 or less	Sweetish odor. Use firm pressure when turning by hand. Slow spindle speed.
	POLYSTYRENE	PLAX, STYRON	120 or less	.015 or less	Mild odor. Requires firm pressure. Gums easily and must be worked at low speed.

METHODS OF CHUCKING SHEET PLASTIC

Chucking plastic disks with hardwood follow block

Plastic sheet is screw-fastened to block of hardwood



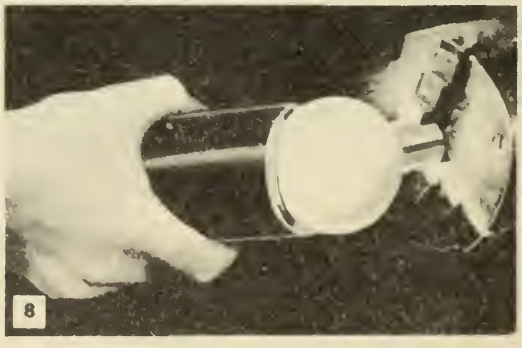
Plastic held by small bolt through the center hole

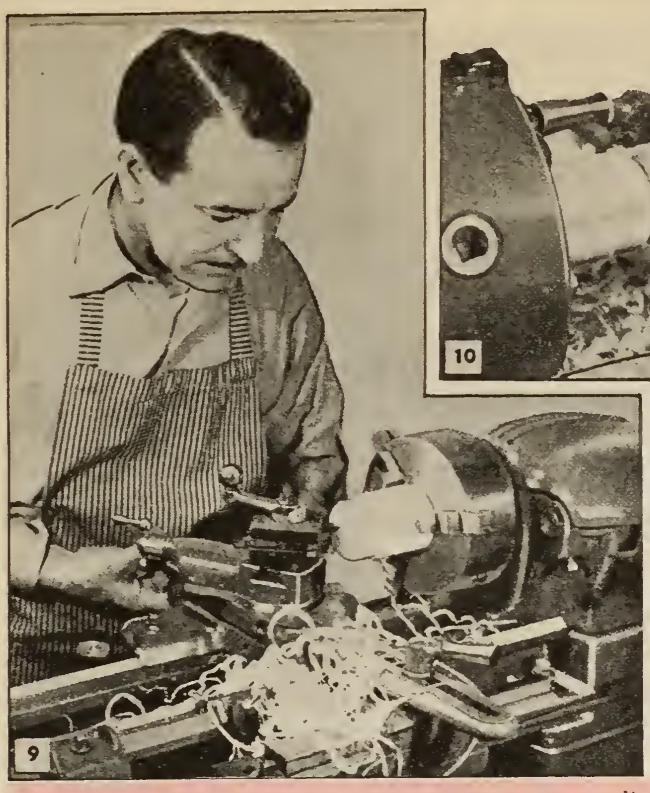
5 F.P.M. to R.P.M.

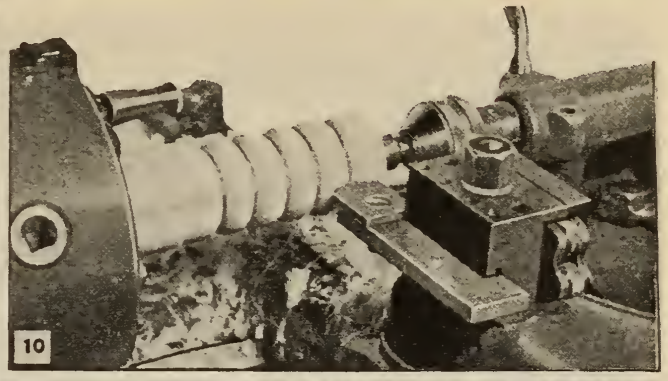
DIA. OF WORK	FEET PER MINUTE						
	100	120	200	300	400	500	600
	REVOLUTIONS PER MINUTE						
½"	764	917	1528	2290	3056	3820	4580
¾"	508	610	1016	1530	2032	2540	3060
1"	382	458	764	1150	1528	1910	2300
1½"	254	305	508	754	1016	1272	1508
2"	191	229	382	574	768	956	1148
3"	127	153	254	382	502	636	764
4"	96	115	191	286	384	476	572
6"	64	76	127	192	256	320	384
8"	48	57	96	144	192	238	288

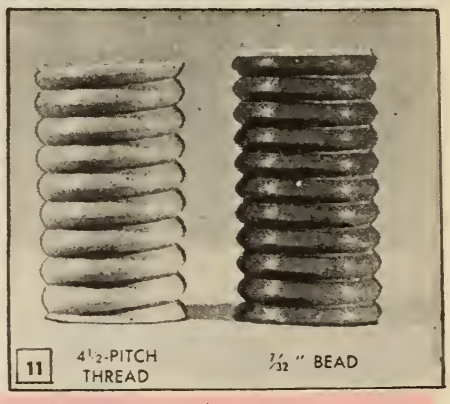
Long, paper-thin chips indicate that turning setup is correct in all details. Negative rake is obtained by holding the tool handle slightly higher than point

Above and below, it's easy to turn plastic balls by using a short length of steel tubing as the turning tool. End of tubing is ground to form cutting edge

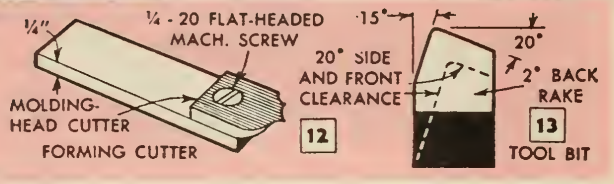








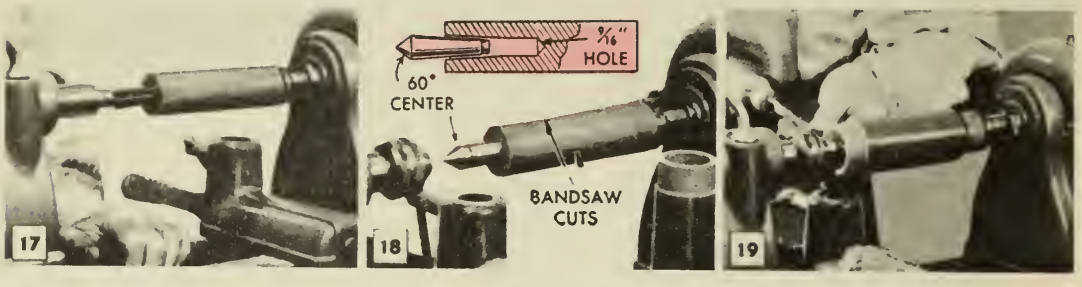
Beads and spirals are turned with a molding cutter mounted on a holder as in Figs. 10 and 12. Work longer than 4 in. should be supported on ball-bearing tailstock center as in Fig. 10. Short pieces are chucked as in Fig. 9



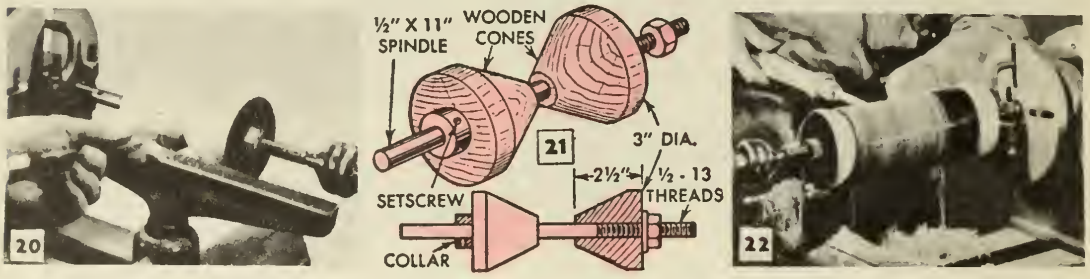
chucking the work. Figs. 2, 3 and 4 picture the fundamentals, and Fig. 9 shows the stock being held in a conventional 3-jaw chuck on a metal lathe. In Fig. 2 the plastic disk is clamped against a wooden backing plate with the tailstock center bearing against a hardwood follow block. In Fig. 3 a square of sheet plastic is simply screw-fastened to a block of hardwood attached to a faceplate. After the turning is completed it is cut free with a parting tool. Fig. 4 shows the simplest method of mounting thin sheet plastic where a center hole is permissible. A bolt passing through the center of a hardwood disk attached to the faceplate, holds the plastic disk firmly in place for turning. Figs. 7 and 8 show how to turn plastic balls to perfect spheres by means of a piece of steel tubing ground square across the end. The ball is rough-turned with the regular turning tools and then finished with the tube tool, the inside diameter of which should be about three quarters of the finished diameter of the sphere.

Plastic rounds (spindles) are mounted between centers in the same manner as are wooden squares. With the center head of a combination square, score two lines at right angles to each other across the ends of the work to locate the centers. Then saw down the scored lines to a depth of about 1/16 in. on one end so that the lugs of the spur center will engage for a positive drive. Drill a small hole in the center of the opposite end of the piece so that the cup center will engage. In a metal lathe, the plastic also can be mounted between 60-deg. centers and driven with a dog just as in metal turning, or short rounds can be chucked as in Figs. 9 and 10. If the piece is more than 4 in. long, the outboard end should be supported by a ball-bearing tailstock center, Fig. 10. The latter illustration also shows how to utilize a molding cutter to form perfect beads by mounting the cutter on a short length of ¼-in. flat steel, Fig. 12. Then the unit is mounted in the toolholder of the metal lathe, Fig. 10. By connecting the carriage to the lead screw, the molding cutter will form a spiral as pictured at the left in Fig. 11. Of course, the thread feed must be equal to the width of the bead. While large beads, Fig. 10, can be spaced accurately enough with pencil marks, narrow beads are spaced by turning

TAPERED HARDWOOD MANDRELS are used in chucking large hollow cylinders. The mandrel is tapered slightly to fit the taper of the cylinder. Mandrel can be solid or built up. For light turning operations, hollow cylinders up to 8 in. long can be gripped internally in the lathe universal chuck, without support at outer end



THE EXPANDING, OR WEDGE, CHUCK is ideal for holding small-diameter work. The chuck is drilled and slit lengthwise to take a standard Morse-taper center and chuck grips work by advancing the center into the hole



THE CONE CHUCK is especially useful for holding thin-wall cylinders. Two tapered turnings are placed on a threaded shaft and held between centers. Work is held securely between cones by tightening a nut on shaft

THE SPINDLE, OR FRICTION, CHUCK holds work by friction alone. For internal turning, the chuck is recessed to hold the work, the recess being slightly smaller than the diameter of the work. Work is limited to short lengths

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27 FINISHING SCHEDULES FOR PLASTICS

TYPE OF PLASTIC	FIRST ROUGH	SECOND ROUGH	FIRST BUFF	SECOND BUFF	EXTRAS
PHENOLICS	Sand 150 Grit, Wet	Sand 240 Grit, Wet	"Learock" 155 or equal (Alum. Oxide)	"Learock" 304B or equal (Whiting)	
ANY	Sand 150 Grit, Wet	Sand 240 Grit, Wet	No. 2-0 or 3-0 steel wool		
ANY	No. 2-0 Pumice with water is equivalent to sanding operation		Any fine buffing compound, usually tripoli		Dry Buff
ACRYLICS	Sand 150 Grit, Wet	Sand 240 Grit, Wet	"Learock" 855 or equal (Sand 400 Grit)	"Learock" 884 or equal (Whiting)	Optional—low bake at 120° for 2 hrs.
ACETATES	Machine Smooth	Sand 220 Grit, Wet	"Learock" 855 or equal (Tripoli)	"Learock" 832 or equal (Lime)	

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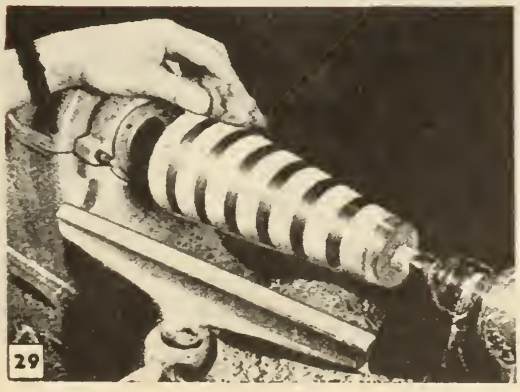
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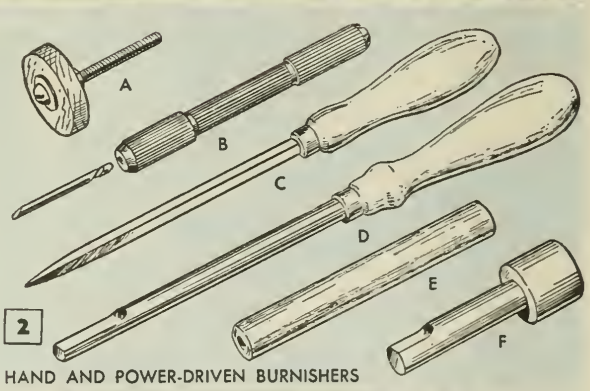
the compound parallel with the work and reading the spacing direct from the micrometer sleeve. For example, the 7/16-in. beading shown at the right in Fig. 11 is spaced 1/32 in. between the crowns, making each individual bead about 7/32 in. wide. In thousandths this is .218, or roughly, .200 in. which is just two full turns of the compound handle for each new spacing. In turning a spiral the width of the bead is .218 in., approximately equal to a 4½-pitch thread. Beads and spirals are worked at slow speeds, using light cuts.

The first rule in ordinary plastics turning is simply to grind the cutting tool with plenty of clearance and keep it sharp. Fig. 13 details the important points in grinding the tool, but this applies to the square tool bit held stationary in the toolholder. In working with hand tools on the wood lathe, the slight negative rake is obtained simply by holding the tool handle a little higher than the cutting point. Among the hand-held lathe tools, the roundnose tool is most commonly used in turning plastics. Because of the radius of the edge, it offers the minimum area of contact and is less likely to leave chatter marks. Figs. 14 to 25 inclusive picture and detail methods of chucking and turning hollow plastic cylinders and tubes of varying length. Wedge chucks, various types of hardwood expanding chucks, or mandrels, and cones are commonly used. As a rule, the chucks are made in the lathe to suit the job in hand.

Fig. 26 shows a common setup on the wood lathe for polishing the plastics job after turning. Fig. 27 gives recommended finishing schedules. Speeds for wet sanding and buffing can be somewhat higher than for turning. When the job is composed of wood and plastic as in Fig. 29 the dry, rough sanding is followed by a rubbing with fine steel wool. After sanding has removed fine scratches and tool marks, a high luster is produced in a jiffy with a buffing compound applied as in Fig. 28. In sanding and buffing, care must be taken not to heat the work unduly.

BURNISHING
puts a fine finish on wood or metal

By Walter E. Burton



HAND AND POWER-DRIVEN BURNISHERS

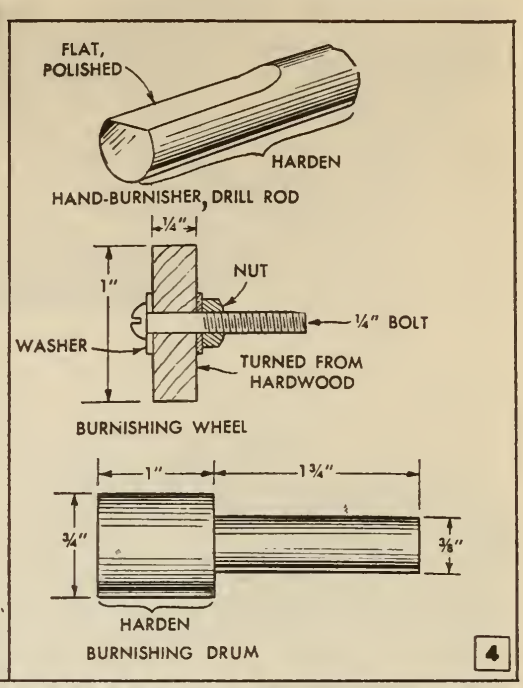
BURNISHING is a method of eliminating surface irregularities without removing material from the surface of the stock. The procedure differs from grinding, sanding and machining. It has a fairly wide range of applications from finishing costly dies to simple polishing of small wood and metal parts in the home workshop.

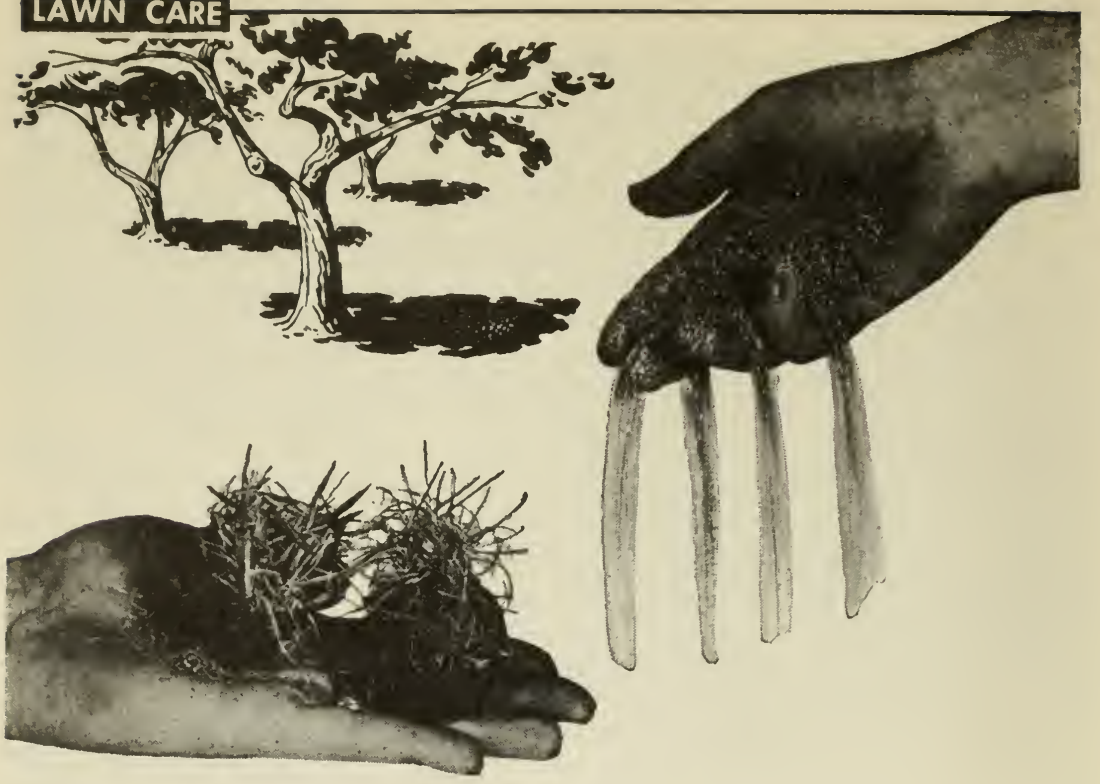
Simple burnishing on metal, Figs. 1 and 6, forms an infinite number of tiny facets which have the effect of changing the reflective properties of the surface, making it appear highly polished. On wood the process "lays the fibers," making the wood appear to be glass-smooth and lacquered in its natural color. Both metal and wood are velvety smooth to the touch after burnishing. Of course, not all metals and kinds of wood can be burnished. Cast iron and soft aluminum generally do not respond satisfactorily to the action of the burnisher. Neither do the coarse-grained woods such as ash. But most of the other common metals and hardwoods, especially the finer tropical hardwoods, can be given

a superfine finish by burnishing alone. In the home shop applications are practical only for such work as refinishing and repairing jewelry, highlighting bronze statuary, renewing carvings, finishing model parts and small wooden novelties.

Burnishing can be done by hand, with a hand-operated tool, or with a power-operated tool. In the first instance the work is held stationary and the tool is moved over the surface in a series of strokes covering the area to be burnished. Figs. 3 and 5 are typical examples of the use of a power-operated burnisher. Representative types of hand and power-operated burnishers are shown in Fig. 2, details A to F inclusive. Those in details A, E and F are designed to be driven either in a drill press or portable drill, Figs. 3 and 5. The power burnishers A and F are detailed further in Fig. 4. The burnisher D, Fig. 2, for use in a lathe freehand, also is detailed in Fig. 4 and shown in use in Fig. 1. Burnisher D, Fig. 2, is made from drill rod, while burnisher C is made by grinding the teeth from the four sides of a square file and fitting a handle. The burnisher B is simply a small twist drill having the shank cut at an angle and the cut surface ground and polished. It is held in a pin-drill chuck and is intended for fine work on small parts.

One of the tricks in getting a fine finish on either wood or metal is to keep the tool moving and at the same time apply a uniform pressure. This is more especially true where the burnisher is power-driven and considerable heat is generated in the process. As a rule, wood is burnished dry, but most metals will take a finer finish when a light oil is used to dissipate heat and prevent any possibility of scoring the surface. When burnishing freehand as in Fig. 1, the tool is held in one hand and the lathe carriage moved slowly left and right with the handwheel. When burnishing with a crowned tool (a diamond wheel dresser also can be used) in a holder as in Fig. 6, the automatic longitudinal feed of the lathe carriage can be used, or the tool fed manually with the handwheel. It should be noted that in such setups, the tool (burnisher) should contact the work slightly below the center line. This position of the tool will offset any tendency to score the surface. As a rule when burnishing metal, the speed of the lathe spindle should not exceed 300 to 500 r.p.m. ★ ★ ★





Which Grass for YOUR Lawn?

By Clifford B. Hicks

WHAT CROP is the most valuable in the United States? Corn? Wheat? Cotton? In terms of investment, surprisingly enough, it is turf—grass for your lawn and parkway, grass for landscaping public buildings, grass for garden paths and golf courses. More money is spent on grass than on any other single crop. It costs us annually about *$15 per person* to keep the green grass growing in the United States. Multiply that figure by the number in your family and you'll find you have a significant investment in turf.

The information on these pages can help you get a good return on your investment in your own lawn. Much of this information was provided by Dr. F. V. Juska, Turf Research Agronomist, U. S. Department of Agriculture.

The map at the top of the opposite page shows the grasses which are well adapted to the various regions of the country. Find your own region and you'll find the grasses suited to your locality. Naturally, the lines on the map are arbitrary, and a grass suited to an area along one side of a line may be equally well adapted to the adjacent area just across the line.

Following below is a description of the various grasses, with some of the characteristics of each. By comparing these characteristics you can decide which grasses you can use to good advantage in establishing a new lawn.

In the listing appears information on whether the grass is established by seed or vegetatively (by planting sprigs, stolons or plugs which spread to form the turf); when to seed or plant it; the seeding rate or manner of planting, and essential information on maintaining that type of lawn.

Region 1A—Northern (Cool, Humid)

Bluegrass strains: Kentucky, Merion, *poa trivialis*. Bent grasses: Colonial (Astoria, Highland); Velvet. Fescues: Creeping red; chewings, Pennlawn. Grasses for southern transition zone: Meyer zoysia; zoysia japonica; U-3 Bermuda.

Region 1B—Northern (Cool, Humid), Pacific Northwest

Same grasses as region 1A.

Region 2—Southern (Warm, Humid)

Bermuda grasses (Tiflawn, Tiffine, Ormond, and Tifgreen); Emerald zoysia, St. Augustine, carpet grass, centipede grass. Grasses for northern transition zone: bent grasses, Meyer zoysia, U-3 Bermuda.

Region 3—Southwest (Irrigated)

Zoysia matrella, Bermuda, carpet grass, St. Augustine, Meyer zoysia, zoysia japonica.

Region 4—West Central

Crested wheat grass, blue grama, buffalo grass, red fescues.

Where irrigation is possible: Kentucky bluegrass, bent grass.

TIPS ON ESTABLISHING AND MAINTAINING A LAWN

When to Establish a Lawn

Depends on where you live and what type of grass you select. In general, if you live in regions 1A, 1B or 4 as shown on the map, seed in early fall. This gives the cool-season grasses a chance to establish themselves during the fall rains, before they go dormant for the winter. There is less competition from weeds, and the grass plants have time to develop a good root system before they are subject to the heat and drought of summer.

In general, if you live in regions 2 or 3 on the map, you'll do best to plant your lawn in the spring, as most of the grasses adapted to these regions thrive and spread out in hot weather and may go dormant during winter.

Another rule of thumb: Establish Bermuda, carpet grass, blue grama, centipede grass, buffalo grass, St. Augustine grass and the zoysias in the spring, the bent grasses, bluegrasses, fescues and crested wheat grass in the fall.

Does Your Lawn Need Lime?

High soil acidity can ruin many lawn grasses. The only way you can be sure of the acid content of your own soil is to send a sample to your county agent, state agricultural college or state department of agriculture for testing. The presence of moss suggests too much soil acidity, but it may also indicate low fertility, too much water or too much shade. The accompanying map shows, on the left, the so-called "lime line," an arbitrary line dividing the country into acid and neutral or near-neutral soils. If you live anywhere in the area covered by the map, your soil may well require lime, but only a soil test can tell you for sure.

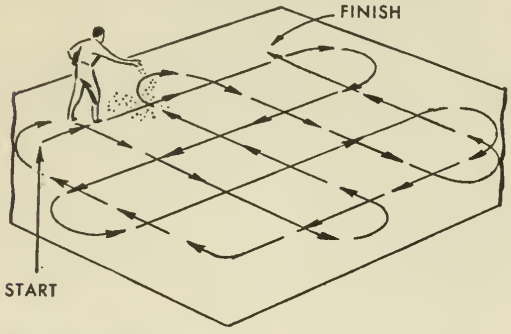
If you need lime, apply 75 to 100 pounds of ground limestone per 1000 square feet. Apply it before you spread the topsoil. Usually a similar application repeated every six to eight years will be sufficient. You can spread lime on an established lawn any time of the year, but fall is somewhat preferred.

Preparing the Seedbed

Remove the topsoil. Then remove all building debris and spade, plow or Rototill the subsoil. Establish the grade of the lawn. For good drainage you need a drop of at least one foot in 50 linear feet. Apply lime and fertilizer as required. Then spread the topsoil evenly, working out any large lumps to provide a smooth, fine seedbed. If you haul in additional topsoil, it may require fertilizer, too. For best results you should have at least four inches of topsoil.

Pregerminating The Seed

Some types of grass, such as Merion blue, have long germinating periods, up to a month or more. You can appreciably shorten this time by pregermination treatment. Put the seed in a cloth bag and soak it in cold water overnight. Then wash the bag under a faucet until the water runs clear. Spread the seed in sunlight, let it dry thoroughly, turning it occasionally. Then sow it. In some cases this will cut germination time in half, speeding the establishment of a new lawn.



Sowing the Seed

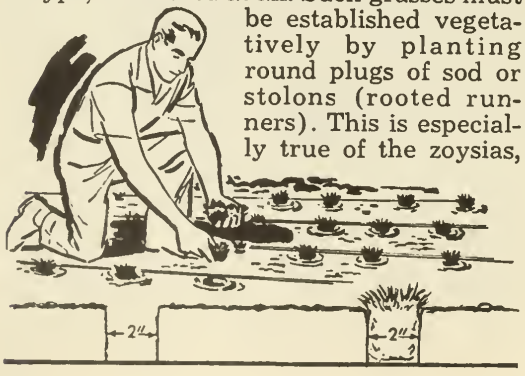
Measure off a test plot of around 500 square feet. You then can weigh out the amount of seed recommended for a plot of this size and sow it. If you find you have the wrong setting on the seeder or are applying too much or too little by hand, you can change the rate before spreading the rest of your seed. It may help you distribute the seed if you mix it with sand or fine soil.

For any given area, divide the seed into two equal parts. Sow one part by working up and down the length of the plot, the other by working crosswise.

Cover the seed lightly by hand raking, then firm the soil by rolling it.

Planting Plugs or Stolons

Many grasses yield seed that is not true to type, or no seed at all. Such grasses must be established vegetatively by planting round plugs of sod or stolons (rooted runners). This is especially true of the zoysias, centipede, St. Augustine and the hybrid strains of the Bermudas.



Prepare the seedbed as for seeding. Plugging tools are available which will cut the sod into plugs two inches in diameter, and also dig holes of exactly the same size in the seedbed. Plant the plugs at measured intervals, no more than a foot apart, closer for more rapid coverage. Use a taut string as a guide in spacing the plugs. Tamp them firmly into place. One square foot of sod will provide about 36 plugs.

Plant stolons or sprigs in a shallow trench, spacing them only six inches apart. At this rate, 15 to 20 pounds of stolons will cover 1000 square feet.

Watering Your Lawn

It is most important that the surface of a newly seeded lawn be kept damp. Seed that has once been exposed to moisture in contact with the soil, and then permitted to dry out, very likely will not germinate. Sprinkle a newly seeded lawn at least once a day and oftener if needed. Only the surface needs to be moist at this time, but it must never be permitted to dry out completely. Sprinkle with a fine mist to avoid dislodging the individual seeds. In general, less frequent sprinkling is permissible if you are establishing a lawn planted with plugs or stolons. However, more water should be applied at any one time to ensure moisture throughout the root zone.

Once the lawn has been established, it is important that the roots obtain water. Don't sprinkle lightly and frequently, as the roots will tend to be shallow, reaching toward the surface for water. Never sprinkle less than an inch of water on an established lawn. You can easily determine how much water you are applying by placing two or three coffee cans or other straight-side containers at various distances from the sprinkler. An inch of water in the bottom of the can, of course, indicates an inch of water on the lawn. In many localities, sprinkling for a given period of time is not a true indication of the amount of water you are applying; water pressure fluctuates in some residential areas and, unless you check, you may be applying much less water than you think.

On the other hand, too much water can harm creeping fescues and some other grasses, and is a waste of a critical natural resource.

In general, water lawns only when they need water. Wilting and browning of grass are your cues. Then apply water to wet the soil to a depth of six inches or more.

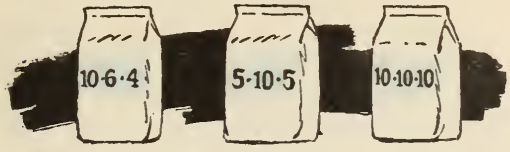
Mowing

Start mowing in the spring as soon as the grass reaches the recommended mowing height. There is one important rule to observe if you are to avoid damage to the grass: *Don't remove more than half the leaf at one time.* Guided by this rule, you can leave clippings to add organic matter to the soil.

Bluegrasses and fescues should be mowed at 1½ to 2 inches; bent grasses, zoysias and Bermudas at ¾ inch, though some bent-grass strains should be mowed as low as ⅜ inch. Close clipping, especially during hot weather, will weaken or kill the bluegrasses. Centipede, St. Augustine and carpet grass are best maintained at a clipping height of one inch. Always keep a mower sharp, no matter what type it is. A dull mower will crush the leaves as it cuts, and such damage will move down the leaf. It encourages disease and may cause the grass plant to die. The crushed cut of a dull mower gives a lawn a brown cast.

Fertilizing

Each type of "complete" plant food (a mixture of chemicals) is labeled with three numbers. Examples are 10-6-4, 5-10-5 and 10-10-10. There are other combinations. In each, the first number indicates *nitrogen,* the second *phosphorus,* the third *potassium.* Each of these elements is essential to plant growth. Any one of the numbers indicates



the *percentage* of that particular element in the analysis. By adding up the numbers, you can determine the percentage of *actual* plant food. For example, a 10-6-4 formula actually has 20 percent plant food; the remainder is inert material to make it easier to spread.

By simple calculation from the formula on the bag you can determine how much *actual nitrogen* you are applying. Apply no more than two pounds of actual nitrogen per 1000 square feet at one time. For example, 1000 square feet can take 20 pounds of a 10-6-4 formula, 40 pounds of a 5-10-5 formula or 50 pounds of a 4-12-4 formula.

For *most* lawns you can't go wrong applying this much fertilizer in the spring and again in early fall. However, there are several exceptions to this general rule. Merion blue, for example, requires high-nitrogen fertility, and should be fertilized several times each year with a high-nitrogen fertilizer. Bermudas, zoysias, St. Augustine and other warm-season grasses should be fertilized frequently through the summer.

Liquid fertilizer should be applied only as a quick booster. Rely on solids for longer lasting effects.

Organic fertilizers (made from sewage sludge, tankage and other waste products) have no phosphorus or potassium, although this may be mixed in by the manufacturer. If not, it should be done by the user.

Killing Weeds and Crab Grass

The best weed killer is a healthy, vigorous stand of grass. This will tend to choke out existing weeds and prevent encroachment by others.

However, chemical weed killers are a part of good lawn management. Available under several trade names and in a variety of forms, 2,4-D will kill many broad-leaved weeds. Follow the manufacturer s directions explicitly. Such directions vary accordingly to the formulation. Do not apply when rain is forecast within the next 48 hours, as rainfall will wash off much of the chemical.

Weed killers can be used on broad-leaved weeds any time the weeds are growing actively, from spring through fall. However, best results are obtained by applying them in early fall, as turf grasses will fill in the sod prior to the emergence of crab grass the following spring. Weeds that are killed in the spring frequently are replaced by germinating crab grass, which means you have solved one problem but inherited a worse one.

Crab-grass killers, too, are effective when applied precisely according to instructions. However, where one application of 2,4-D will kill most broad-leaved weeds, crab grass must be given at least three successive treatments spaced seven to ten days apart. The crab-grass killer should be applied any time after crab grass emergence up to the two-leaf stage of growth. Another excellent measure for controlling crab grass is to rake the lawn vigorously in late summer to make the crab-grass blades

stand up, mow closely, then rake up the clippings. This will reduce invasion of crab grass in subsequent years by eliminating a big share of the seed.

General Lawn Maintenance

To reseed an established lawn, rake the bare areas vigorously. Fall seeding in late August or early September gives the best results with cool-season grasses, but fair results can be obtained with spring seeding providing it is done before April 1 and kept well-watered. To convert an established lawn to Bermuda or zoysia, plant sprigs, stolons or plugs throughout the existing turf on one-foot centers any time from May to late August. The grass will spread.

TYPES OF GRASSES

BENT GRASSES

Bent grasses should be used only if the homeowner is willing to spend considerable time, care and money on maintenance. They are especiall adapted to the New England states and the Pacific Northwest. All bent grasses survive in the shade but prefer the sun. They are fine textured and spread to form a dense turf. Establish a new lawn in September, sowing at a rate of four ounces of seed per 1000 square feet. Seedbed must be well fertilized, and bent grass should be fertilized once a month during growing season. It must be watered regularly during hot, dry periods. Disease is the biggest problem; in some localities fungicides may have to be applied every seven to ten days during periods favorable to the development of disease. All bent grasses should be mowed below ¾ inch, some below ½ inch, with a reel-type mower. Many mowers will not cut this low. Varieties of bent grass include: Creeping bent grass, which is not generally recommended for lawns. Velvet bent grass has the finest texture but is not as aggressive in spreading and is slow to recover from injury. Colonial is best adapted for lawn use. Strains of Colonial include Highland, Astoria and Rhode Island.

BERMUDA GRASSES

Also known as wire grass, Bermuda is a persistent, long-lived perennial. It is very aggressive, spreading vigorously so that it may become a pest in gardens adjoining the lawn. Very drought-tolerant, it stays green during long dry periods. Dense turf with excellent wear resistance. Requires bright sunlight, will not tolerate shade. Almost all Bermuda grass is established vegetatively, usually by planting stolons or plugs one foot apart from spring until early August. Should be well-fertilized while it is spreading, then fertilized four times each growing season. Should be mowed below ¾ inch. Varieties include: Ormond, with a medium-fine texture; Tiffine, with a very fine, very dense texture and excellent disease resistance; Tifflawn, with a medium-fine texture and very rapid growth; Tifgreen, a new and improved variety; and U-3 Bermuda, with excellent wear resistance, the most cold-tolerant strain of the Bermudas.

Rolling a lawn lightly in the spring will press down any plants that have been heaved by winter freezing and thawing. However, never try to use a roller as a means of leveling a lawn. Frequent rolling will compact the soil.

Aerate the turf if the soil becomes compacted. This means spiking holes in it, a practice which permits water and fertilizer to penetrate deeply for heavy root growth. Hand tools are available to do the job, or you can rent a machine from an equipment dealer or a landscape gardener. Also you can have the work done on contract. ★ ★ ★

BLUEGRASSES

These are the old stand-bys for cooler regions. Most of them have medium-fine leaves and form a dense turf. Shade-tolerant in the South. If not watered, bluegrasses may go dormant during hot dry spells and lose much of their color, but resume growth in the fall. They require watering , as long, dry spells may cause permanent injury. Establish in August or early September, seeding at a rate of two pounds per 1000 square feet. Fertilize the seedbed well and apply a high-nitrogen fertilizer fall and spring. Mow at 1½ inches or higher. Kentucky is the best-known strain of bluegrass, and has a medium-fine leaf and vigorous rootstock. *Poa trivialis* will withstand shade and dampness but suffers damage in heat and drought. It is good for shady lawns. No creeping rootstocks. Merion is superior to other bluegrasses in disease tolerance, drought tolerance, appearance and vigor, although susceptible to rust in some areas. It is extremely slow to germinate. Requires high-fertility soil, should be heavily fertilized spring and fall, lightly several times during the summer. One drawback: It is more expensive than other bluegrasses.

BUFFALO GRASS

A native grass, good for lawns in the West Central states. Fine-leaved, it spreads rapidly by surface runners to form a dense, matted turf. Begins growing in late spring and continues until frost. Highly wear-resistant. Grayish green in color, turning to light straw after frost. Can be established vegetatively or by seed. Sow 12 ounces of seed per 1000 square feet. Get treated seed for faster germination. Fertilize in the spring. Mow at 1½ inches or higher. Little watering required.

BLUE GRAMA GRASS

Another drought-resistant grass for the West Central states, it thrives in heavy soils. Medium-fine leaves, low growing. Growth ceases during drought but resumes when water is available. Readily established from seed. Seeding rate is one pound per 1000 square feet. Fertilize at least each spring. Mow at 1½ inches or higher.

CARPET GRASS

A low-growing perennial that spreads above

ground by creeping stems which root at every joint. Can be established vegetatively, but the simplest method is by seed, which is abundant and cheap. Produces a dense, compact turf under close clipping. Grows best in sandy-loam soils. Tolerant to heavy trampling. Grows in partial shade if soil is moist. Resistant to insect and disease damage, but is not tolerant of salt-water spray. Thrives under limited fertilization on poor soils, but is sensitive to lack of iron. Mowing frequently to height of one inch with a rotary mower is recommended.

CENTIPEDE GRASS

A low-growing grass which spreads by stolons to form a very dense mat. Requires little maintenance and is good for recreational areas. May spread to become a pest in flower beds. Will survive without fertilization, but produces dense turf upon application of high-nitrogen fertilizer. Establish vegetatively. Plant plugs or stolons six inches apart. Five to ten square feet of sod will establish about 1000 square feet of lawn. For best results, fertilize fairly heavily in spring, then lightly every month or six weeks during growing season. Inexpensive. Mow at ½ to 1 inch. Water when turf begins to show signs of drought.

CRESTED WHEAT GRASS

Excellent for cool, dry areas. Coarse leaves, somewhat hairy in appearance. A deep root system sustains the grass through long, dry speels, even though grass may go dormant. Establishment largely depends upon available moisture, and it can be seeded in fall or spring over much of its region of adaptation. Seeding rate is two pounds per 1000 square feet. Fertilize both spring and fall. Cut at 1½ inches or higher. Little watering required.

FESCUES

Hardy and robust, they are especially adapted to shady, dry areas. There are many strains that vary widely in texture and growth. Creeping red fescue has bright green leaves, creeps by underground stems. It is frequently mixed with bluegrass in prepared lawn seed. Chewings fescue is similar but does not creep. Pennlawn fescue is a new and improved strain of creeping red fescue. It has greater tolerance to leaf spot, better foliage density, faster rate of spread and greater ability to withstand close clipping. Establish fescues by seed, sowing at a rate of two to three pounds per 1000 square feet. Mow at 1½ inches or higher. Less fertilizer required than for most lawn grasses. One light application fall and spring will usually do the job.

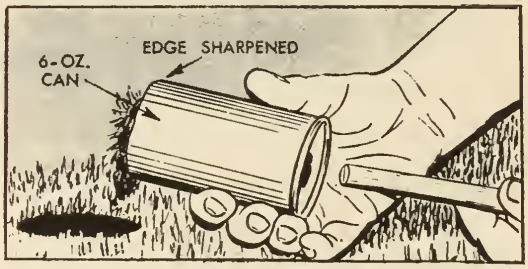
ST. AUGUSTINE GRASS

A creeping, coarse grass that thrives in shaded areas and will withstand salt spray. Dense, wear-resistant sod. Establish vegetatively. Should be well fertilized with nitrogen, especially in sandy soils. Fertilize at least once each year, preferably at start of growing season.

ZOYSIAS

Excellent turf, but adapted mainly to the South and the "twilight zone" between South and North. In areas farther north zoysias will live but will not spread. Zoysias need bright, hot sunlight. Most of them will spread during such days to crowd out many other lawn grasses and weeds, forming a beautiful, uniform turf. They are drought tolerant and resist disease, insects and wear. Zoysias turn a dead, unattractive brown in winter, though this may be a very short period in the Deep South. Establish them vegetatively in the spring, planting plugs one foot apart. One square foot of sod provides up to 36 two-inch plugs. Meyer zoysia is a fine-leaf strain of zoysia japonica, with a silky feel. Grows well in unfavorable soils. Unsatisfactory in heavy shade. Especially adapted to the twilight zone. Expensive. Emerald zoysia is superior to other strains in the Deep South. Tolerates shade. Slower spreading than Meyer zoysia. Zoysia japonica is not as dense as most zoysias, but has excellent winter hardiness and will survive farther north. Can be planted by seed or vegetatively. If seeded, sow two pounds per 1000 square feet. Insist on hulled seed. In general, zoysias should be fertilized in spring after last killing frost. An application of fertilizer every month or six weeks through the summer will make turf thrive. Mow below one inch.

Zoysia-Grass Plug Cutter Made From Can and Dowel



Propagation of Zoysia grass is done through the planting of plugs 2 in. in diameter, as the plant does not produce seeds. Cost-free is this tool that cuts holes to receive the plugs. It consists of a frozen-juice can that has the edge of the opened end filed or ground to form a cutting edge. The closed end of the can has a hole cut in it about ⅝ in. in diameter, through which a 6-in. length of broomstick or dowel can be pushed. To use, place the sharp edge of the cutter over the spot to be "drilled," push it down into the soil with a hand or foot. Remove the cutter and force out the soil plug by pushing the dowel. The Zoysia plug now can be dropped into the hole and pressed down firmly with your foot. When the grass has spread out well, the cutter can be used for cutting plugs to be placed in other areas of your lawn, in holes bored by the cutting tool.

Oliver Grant, Springfield, Mass.

HOW TO CARE FOR YOUR LAWN

THE MAIN INGREDIENT of an attractive landscape that brings out the beauty of your home is an evenly smooth and green lawn. It can be thought of as the canvas upon which the picture of your garden is to be created. The flowers and hedges that border the lawn, the trees which are surrounded by the green turf and the ornaments which are placed on the grass—all these beautify the landscape only when an attractive lawn serves as a background. Since it is such an essential and permanent source of beauty, the construction and maintenance of a lawn deserve careful attention.

Establishing a New Lawn

Grading: If you are establishing a lawn for the first time on your property, your first and foremost task is to obtain a properly graded area upon which your lawn is to grow. Should the job of grading appear to be a difficult one, it is advisable to hire a landscape contractor to do the heavier work. These contractors are equipped with bulldozers, rototillers or similar cultivators with which they can accomplish the job in short order. You can usually hire these operators and their machines by the hour at reasonable cost.

One of your first considerations in grading is direction of slope. Generally speaking, northern and eastern exposures are the most desirable. Hot dry weather affects southern and western slopes more, especially if water drains off the surface quickly.

In grading, it is best to have natural and gradual contours. Severe grades (Figs. 1 and 2) should be avoided wherever possible. It is difficult to establish and maintain a lawn on steeply graded ground because of washing out in wet weather and extreme drying in periods of drought. Moreover, steep grades complicate mowing. Every lawn should, however, have some slope, no matter how slight it may be, to insure runoff of excess water. A pitch of at least 6 in. to every 100 ft. of lawn is generally recommended. Ideal grading provides a slight slope away from the house in all directions, just enough to permit good drainage. Any change in grade should be as gentle as possible, unless an abrupt terrace is to be a part of the scheme of the landscape.

If a severe drop in grade is absolutely necessary, a dry retaining wall at the foot of the slope helps, as shown in Fig. 4. Otherwise, terracing is recommended so that the grass slopes will not be greater than one foot of fall to three of horizontal distance. Where there are several terraces, a series of dry wall embankments with grassed terraces between provides a suitable arrangement. To make the mowing of terraces easier, slopes at the top and bottom should

be leveled off gradually. The top of the slope or terrace should be convex, and the bottom concave (see Fig. 3). With this arrangement the lawn mower will cut without scalping the crest or skipping the base.

The actual grading should be done in two parts. The first part consists in working with the subsoil grade. However, before the subsoil is touched, scrape off the topsoil and pile it to one side. Then grade the subsoil, giving it the same contour as the final grade. It will, of course, be lower than the final grade to allow an even depth in which the topsoil will be restored or added. The time to provide a good drainage system is when you are working on the subsurface grading to prevent subsequent damage to the topsoil layer. This is also a good time to install any underground utilities such as a sanitary sewer, water lines to the house, major supply lines for lawn irrigation purposes, etc.

When you come to the surface grading, distribute the topsoil as evenly as possible, making sure that there are no thin spots to cause poor areas in the lawn. Special care should be given when grading slopes as there are often places that are cut and scraped severely, removing all topsoil and not replacing it in sufficient quantities.. Never allow the subsoil to peek through. It is particularly important to have good depth of topsoil in lawn areas having considerable slope.

If there are large trees on the area to be graded, you will want to protect them during grading operations. Consult an experienced tree surgeon if the new grade is to be decidedly lower or higher than the natural grade under the trees. If the grade is to be lower, leave a sloping mound of soil around the base of the tree, extending out as far as the drip of the branches. The same amount of soil as was there originally should remain over the root zone of the tree. In the event that the grade is higher, provide some arrangement for a dry well or a fill of gravel and stone under the tree so the roots continue to get the necessary air and moisture.

Preparing the soil: The importance of good soil in producing healthy vegetation was discussed extensively in the previous section. This is as true for grass as it is for rare and delicate flowers. A good rule to follow in preparing the soil for grass is to prepare it as if it were to be a flower bed. Grass grows best in a light loam soil. A soil of this type absorbs and holds the necessary amount of moisture but is porous enough for the excess water to drain away and the air to penetrate it freely.

Before anything can be done to improve your soil, all rubbish—chunks of concrete, boards, plaster, etc.—should be removed.

FIG. 1

A sharp grade, like the one above, should be avoided when establishing a lawn. There will be some washing away in hot weather and drying during drought

FIG. 2

The grade of the lawn above is slightly better. However, mowing this lawn will still provide a problem, as the top will be scalped and the bottom ignored

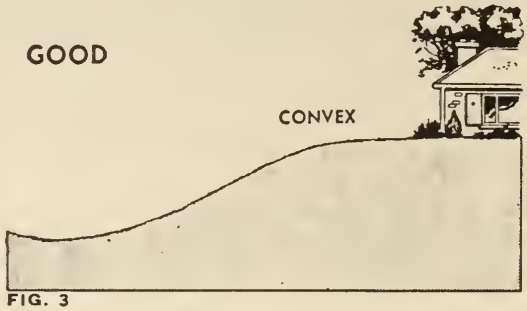


FIG. 3

Every lawn should have some slope to allow the excess water to run off. The above lawn has an excellent slope with a convex top and concave bottom

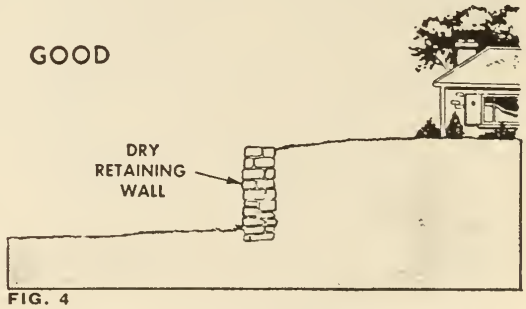
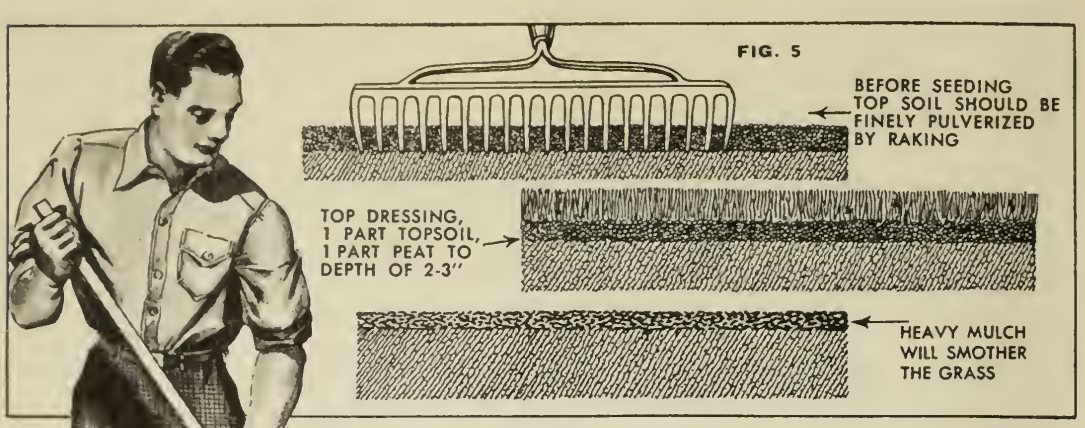


FIG. 4

A severe drop in grade should be avoided wherever possible in making a lawn. But if an abrupt terrace cannot be avoided, a dry retaining wall at the foot of the slope should be constructed to aid drainage



Using a bamboo rake, if possible, spread the top dressing over the ground and work it into the soil. Fall is the ideal time for this operation several days before seeding

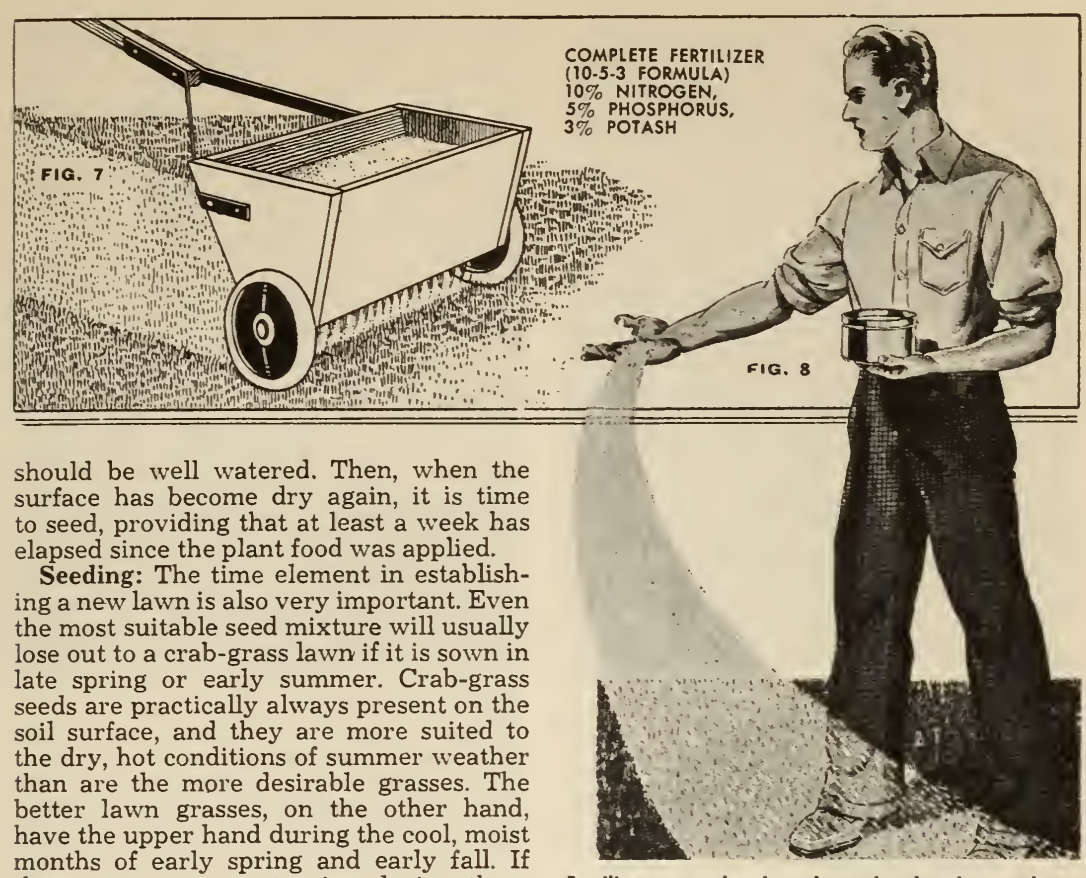
Such trash will interfere with the movement of water in the soil and good grass will not grow.

For the best results in establishing a new lawn, prepare the ground some time before the grass is to be planted. Early summer preparation for fall planting and autumn cultivation for spring sowing are recommended. By preparing the seedbed in early summer for fall seeding, there will be time for the weed seeds to germinate. These weeds can then be killed by subsequent cultivations before seeding. Likewise, fall preparation for spring planting allows enough time for many of the annual weed seeds in the surface soil to germinate before fall is over and be killed by winter freezing. Settling of the ground will take place over the winter and the alternate freezing and thawing of the fallow surface soil will make it more mellow.

The ideal soil for a lawn can be established by beginning to build up the soil a year prior to seeding. This is done by sowing the area that is to become a lawn in soybeans, allowing the crop to grow for a season, then plowing the soybeans under in late summer.

If the soybean treatment cannot be given to the soil, it should receive a dressing of about 2 in. of well rotted manure. Then it is to be plowed or spaded to a depth of about 8 in. and thoroughly raked and rolled. If the soil is dry after it has received these treatments, it should receive an occasional watering, but otherwise should be allowed to lie idle until just before seeding time. Remove all weeds that have popped up, after which cover the entire surface of the soil with a top-dressing (one part good topsoil to one part peat) to a depth of 2 or 3 in. Details of this operation are shown in Figs. 5 and 6. The mineral requirements of the soil should be met by adding 3 lbs. of nitrogen, 1½ lbs. of phosphorus and a still smaller amount of potash for every 1000 sq. ft. of soil area. This will amount to about 20 to 30 lbs. of complete fertilizer of an analysis of 10-5-3 or 12-6-4 per 1000 sq. ft., as shown in Fig. 7. Superphosphate is a good fertilizer which contains the three important elements. It should be mixed in the upper 4 in. of soil at the rate of 25 lbs. per 1000 sq. ft. This fertilizer will add enough phosphorus to the soil to last for a number of years. Other good sources of nitrogen which also carry small amounts of other elements are cottonseed meal, sheep manure, soybean meal and sewage sludge. Bonemeal is a suitable source of phosphorus and also contains a little nitrogen.

Now that the soil has been properly fed, it is ready for cultivation. The necessity for thoroughness here cannot be overemphasized. A finely pulverized seedbed is a must, and hand-raking will do the best job when the soil is in the best condition to be worked—that not-too-wet, not-too-dry soil should crumble easily. When all the stones and pieces of sod have been removed and a smooth seedbed is obtained, the soil



Fertilizer may be broadcast by hand, as shown above, or with a seed and fertilizer spreader. The latter method gives a more even distribution

should be well watered. Then, when the surface has become dry again, it is time to seed, providing that at least a week has elapsed since the plant food was applied.

Seeding: The time element in establishing a new lawn is also very important. Even the most suitable seed mixture will usually lose out to a crab-grass lawn if it is sown in late spring or early summer. Crab-grass seeds are practically always present on the soil surface, and they are more suited to the dry, hot conditions of summer weather than are the more desirable grasses. The better lawn grasses, on the other hand, have the upper hand during the cool, moist months of early spring and early fall. If these grasses can get going during these seasons, they will have a head start on the crab grass and other weeds and can easily crowd out most of the competing weeds when summer rolls around.

Fall or spring—which is the best time for sowing grass seed? In practically every instance, fall planting wins out over that of spring. Fall is nature's chosen time for grass planting. In the first place, grass roots have a chance to grow more extensively in the fall. Moreover, weeds stop growing as the weather becomes cooler. That's when the young grass seedlings have the ideal moisture and temperature conditions for germination and growth and can grow without danger of being crowded out by the weeds.

However, if you do not have the opportunity to do your sowing in the fall, early spring is a good second choice. The earlier in the spring you seed, the better your results will be. You can start spring planting even if there is still snow on the ground, but it will have to be that late and light snow which is the last stand of winter. It is best to wait until the frost is out of the ground, since seed sown on snow or frozen ground may be carried away if there should be a quick thaw.

When you are ready to seed, choose a day when the air is quiet. The grass seed may be sown either by hand or with a spreader. You can obtain a more even and quicker distribution with a spreader (see Fig. 10), but hand sowing is almost as satisfactory, especially if your lawn area is small. If a seed mixture is used, it should be thoroughly mixed and divided into two portions. One part should be broadcast over the soil while walking lengthwise over the area; the other portion is to be sown while walking at right angles to the direction of the first sowing. From 3 to 5 lbs. of seed per 1000 sq. ft. will be needed to sow a new lawn.

It is difficult to state definitely the best procedure for covering the seed. The big question is whether raking or brushing is better than allowing nature to bury the seed by the alternate wetting action of rain and drying process of wind and sun. To be on the safe side, the gardener would be wise to give an assist to nature by a light hand raking or by dragging a flexible object, such as a weighted sack or steel door mat, over the area. This will spread the grass seed more evenly and at the same time cover it lightly with loose soil. The seedbed should then be rolled to bring the

FIG. 9
The above seed and fertilizer spreader is also a yard cart. The hopper is removable and made of plywood reinforced with cleats at the joints, and fits snugly into the spreader hopper. The bottom is flat so that when mounted on the spreader it is high enough to clear the agitator. Rope handles on both sides of the hopper make it easy to carry to and from the cart

FIG. 10 National Garden Bureau
Although a seed spreader is a relatively expensive item, it is well worth the price because of the even distribution of grass seed you can obtain with it. Divide your grass seed mixture into two portions. Spread the first portion in horizontal strips, as shown above. Then operate the spreader over the same area at right angles to the first distribution

soil particles in close contact with the seed. A good practice to follow is to rake after the first part of the seed is sown and roll after the second sowing. A light roller is advised, just heavy enough to firm the soil but not pack it.

A top-dressing for the newly seeded area is optional. If you do use top-dressing, ⅛ in. of screened topsoil or compost will serve the purpose. Avoid the use of raw peat moss, as the grass roots may grow up into the peat instead of down into the soil. Manure should not be used as a covering unless it is well rotted or composted. Straw may be used after summer seedings or to protect slopes from washing. Not more than 3 in. of loose straw should be used and this is to be removed as the grass gets well started. Covering the grass seed becomes more important when it is planted on a slope, as the seed is likely to wash away before it can take root. Burlap, cheesecloth or heavy fiber paper can be pegged down over a seeded slope (Fig. 11), providing that the cover is removed as soon as the seed sprouts so that the grass will not be smothered. Erosionet, a loosely woven open-mesh material, is another good covering. It can be left on the ground to rot away or taken off as soon as the grass is well started.

Moisture is essential to germinate the seed as well as to keep the grass seedlings from perishing. The newly seeded area should be lightly sprinkled after it is rolled. Otherwise, seeding before a rain is a good procedure. Keep the newly planted lawn moist down to a depth of several inches at all times. In sprinkling the soil, use a fine spray so that the seeds will not be washed away or made to grow in patches. Even after the grass is up, it is important to prevent the soil from drying out. Many plantings are lost at this stage because the tender seedlings dry up easily and disappear after but a few hours' exposure to a hot sun. Two or three waterings with a fine spray may be required on bright days until the grass gets a good start. The new lawn has to be kept soaked so that the grass will be deeply rooted. Mere surface-watering will result in surface-rooting, and the first drought that comes along will kill much of the grass. The best way to water the lawn is to use a spray or canvas soaker. Fig. 12 shows an improvised sprinkler you can use. You can also prop the end of a hose on a forked stick, or on a device such as the one shown in Fig. 13, and let it spray. To test the depth to which the water has soaked, slip a knife into the soil and see how far down it slides readily. The sprinkler will have to be kept in one spot for at least two hours to give

most soils a good soaking. Another way to test the amount of water reaching the grass roots is to set cans at varying distances from the sprinkler and later see how much water collects in each can.

With plenty of moisture and moderate temperatures, the new grass seedlings will appear in about 7 to 10 days if there is redtop (previous pg.) in the mixture. When the grass has reached a height of about 2 or 3 in., it is time to mow the new lawn. Never let the new grass grow longer than 3 in., because this can cause the lower part of the plants to turn yellow and the grass will be weakened. In clipping the new lawn, do not cut the grass blades shorter than 1½ in. If the grass is cut shorter than this, the development of the root system will be discouraged, and this increases the possibility of the plants being injured by extreme summer heat. By setting the mower blades at a 2-in. height, you will obtain the best results. Since new grass is thin and fine bladed, use the mower as gently as possible, and make sure that the cutting blades are well sharpened. Avoid damaging the lawn with the mower wheels. It is particularly important to stay off a new lawn when the ground is soft and wet as the grass seedlings are torn out easily.

After the first mowing, bare spots may show up in the lawn. These areas should be resown with seed immediately, regardless of the season, to prevent troublesome weeds and wild grasses from getting started. To assure that you reseed with the same blend of grass, it is wise to save some of it when seeding your lawn for the first time. A good way to store grass seed is suggested in Fig. 15.

If you choose to plant your lawn in the fall, you may wonder how you should protect it during the winter frosts. The answer is simple—you need do nothing. Young turf is not benefited and may even be harmed by protection from cold, so no winter covering is recommended. The young grass can withstand cold weather better than you think.

Sodding: This is an expensive way to establish a new lawn, but this practice is becoming more common and satisfactory around many new homes which have limited lawn areas. Sodding is desirable (1) on steeply sloped areas, (2) on borders of lawn areas, (3) at the edges of drives and walks, (4) on borders of planting areas to prevent soil from washing into them and to compose neat edgings, (5) where an immediate lawn effect is wanted and (6) upon small areas where subsequent care of a newly seeded lawn would be neglected or become too troublesome.

Good sod should be made up of densely rooted grass of the desired kind, and free

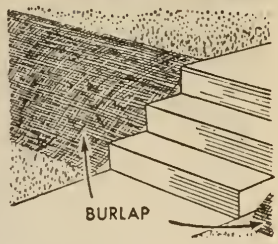


FIG. 11
Newly seeded grass on slopes and terraces should be covered so that the rain will not wash it away. Burlap bags can be pressed into the earth, as shown at the right. It will not be necessary to remove the cloth. It will rot

FIG. 12
Here is a good substitute for a garden-hose nozzle. It is made from a beverage can of the type that has a narrow neck. Solder a pipe coupling to the nek of the can and screw it on the hose. Punch several tiny holes into the can, the number depending on the spraying stream desired when the water is turned on. In watering a newly seeded lawn, only very minute holes should be used

FIG. 13
Your lawn hose and nozzle can be used to water a newly seeded lawn without the aid of a sprinkler if the arrangement pictured at the right is used. Merely bend a piece of heavy wire to support the hose in a vertical position. The device holds the hose so that it may be moved easily

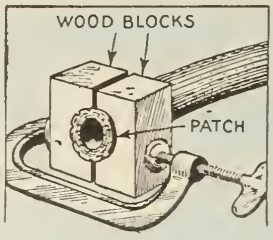


FIG. 14
A leak in a garden hose can be patched with the type of cold patch used on inner tubes. Use a clamp to put pressure on the patch while the cement is setting. If the hose is ribbed, it should be smoothed

FIG. 15
If grass seed is stored for any length of time, it should be protected from the moisture in the air to prevent spoiling. This is done by placing the sack of seed in a barrel and filling the barrel with ground feed. Pour a layer of feed over the bottom of the barrel before the seed sack is inserted

FIG. 16
After the ground has been well cultivated, lay the strips of sod snugly together but without crowding

from weeds and undesirable grasses. The strips of sod should be cut into pieces of convenient length and width and of a uniform thickness to insure an even surface when laid upon a well-prepared base. A width of one foot is about right with the thickness of sod varying from 1 in. for bentgrass sod to 1½ to 2 in. for bluegrass. Bentgrass sod can be thinner because of the extremely shallow-rootedness of this type of grass.

The best time of the year to lay sod is in the spring about the time when grass starts to grow. The seedbed is prepared as for seeding, and the strips of sod laid as in Fig. 16. They should lie together snugly but not be crowded. Then spread over the entire area a sandy loam topsoil, enriched with fertilizer and containing the seed of the native sod. About 1 cu. yd. of topsoil and 1 lb. of seed per 1000 sq. ft. of lawn area is the correct proportion. This mixture will settle into the crevices between the sod pieces, fill in the low spots and stimulate the grass growth until the roots become established in the soil below. The next step is to roll the newly sodded lawn to assure contact between sod and soil. The sodded area should then be watered. When sufficiently dry, roll the sod again to develop a smooth surface and to press the turf into contact with the soil below.

In sodding banks where there is a danger of the sod slipping, set the pieces lengthwise across the bank and hold them in place with wooden pegs. Peg each sod strip 1 to 2 in. below each upper corner and also at a point midway between corners. Drive the pegs through the sod and into the bank, deep enough so that the tops of the pegs will be slightly below the cutting blades of a mower.

Growing grass under trees: Establishing and maintaining a lawn under trees present a special problem. Here there are limitations in sunlight, plant food and moisture. Certain species of grasses, such as chewings fescue and woodlawn meadow grasses, can thrive with a minimum of light.

Grass under trees suffers from lack of moisture and plant food because shade trees withdraw these elements from the surrounding soil very rapidly. Therefore, the soil under trees has to be heavily and frequently enriched and watered to maintain grass.

Winter lawns: In the southern part of the United States, it is possible to maintain green growth on the lawn the year around. The winter grasses are, of course, different in species from those that grow in the warmer seasons. A winter lawn is, therefore, treated as a separate and annual crop. The grasses used are shallow rooted and will not forage deep enough into the ground to injure or disturb the permanent grasses. A complete plant food is needed to supply the winter grasses with nutrients.

These steps should be followed to establish a winter lawn. First, cut the grass on your permanent lawn close and remove the clippings early in the fall. Then apply a complete plant food evenly on the surface, using about 4 lbs. per 100 sq. ft. of area. Sow winter rye grass seed evenly, rake it into the soil lightly and soak it down thoroughly. Daily watering is required until seed germination. When spring arrives and the permanent grasses start to grow, the winter grasses can be easily raked out.

When you are raking, watch for weeds that were hardy enough to last the winter. These weeds are harmful to a healthy soil and lawn.

Renovating an old lawn

IF THERE IS A LAWN already established on your property, you may be faced with the task of trying to improve it. It may be that your lawn is so poor that you are debating with yourself whether to dig it all up and start from scratch or to try to build up what you have. Your final decision will have to rest on what attempts you have made in the past to improve your lawn. If repeated attempts to bring about a healthy, attractive lawn have failed, there is probably something fundamentally wrong. It would be useless to continue the same practices to improve your lawn when they have repeatedly failed you in the past. Instead, you should make an effort to find out what is wrong and correct it.

Poor soil might be the cause of a poor lawn. Therefore, your first task would be to examine the soil. You can do this by merely digging up a sizable chunk, going down into ground at least 10 or 12 in. and spading up the sample. Examine this chunk of soil carefully. Is it yellow or almost white when dry? If so, you probably have a stiff clay soil on your hands. Grass roots would make little headway in such soil because of poor drainage and aeration. On the other hand, the soil may turn out to be stony and gravelly. This is the type of soil from which the water drains away so rapidly that neither moisture nor nutrients can be absorbed by the grass roots.

If your soil turns out to be one of the two extremes mentioned above, it might be best to remove 6 to 8 in. of the soil and import good topsoil. Or, you can make your own topsoil by preparing a mixture of soil, leaf mold, fertilizer, etc., with a sifter-mixer of the type shown in Fig. 17. However, this may be impractical where the lawn area is large. Your alternative then will be to work in soil of opposite texture and some organic matter with the soil.

Here is a combination soil sifter and mixer that you can build yourself to prepare topsoil for your lawn and garden. It will accommodate a fairly large quantity of soil, leaf mold, fertilizer, etc. in one mixing. The frame is mounted on four legs set into the ground and diagonally braced. The screen frame rides on four roller-skate wheels and the track is protected by a sheet-metal guard. After good soil has passed through the screen, the siftings are dumped into a container in the manner indicated in the drawing. Flat-iron stops prevent the skate wheels from running off the end of the sifter track
FIG. 17

FIG. 18
Reseeding to patch thin spots in the lawn is hard to do without disturbing the grass. A household meat tenderizer is ideal for this purpose, as shown above. When pressed into the soil, the tenderizer loosens the soil and leaves small holes for the seed, but does not uproot the grass presently growing in that spot

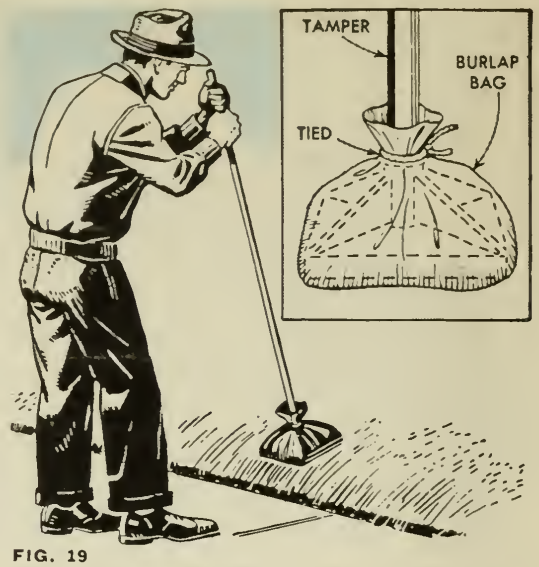


FIG. 19
When tamping grass seed into the soil, a tamper often becomes difficult to manage if caked with wet soil. Burlap wrapped over the head of the tamper, as shown above, will help this situation by keeping the wet soil from sticking to the tool. Once in a while the cloth may have to be removed and cleaned

Improper grading also may cause you to have a poor lawn. A flat lawn may sag in spots so that puddles collect and drown the grass. On the other hand, the slope may be so severe that soil washes away during rains and droughts also take their toll. The solution here would be to spade up your old lawn and regrade the area for a new one. Install a drainage system if necessary and provide a sufficiently deep topsoil of good texture.

Cultivation: In time, many good soils become too compact because of trampling and settling. In such situations, spade up or plow the ground, incorporate material to lighten the soil and feed it with plant nutrients. If only limited spaces, such as low spots or areas under trees, need to be treated, the soil can be loosened and cultivated by 6 to 8 in. deep perforations. Drive an ordinary spading fork down as far as it will go into the ground and work it back and forth to enlarge the openings. The fork should be inserted at close intervals, the openings being made every few inches. Brushing sharp sand or compost into the holes will assure better movement of air and moisture through the soil.

Having decided to turn over your old lawn, you may wonder how deep you should spade. This will depend on the depth of the topsoil. Only go as far down as your topsoil extends, taking care not to bring up any subsoil. As long as you are going to the trouble of renovating your lawn, do a good job of it. Fill in all low spots with good topsoil and remove any high spots by taking away some of the subsoil and then replacing the topsoil.

Maybe you won't have to renovate your lawn completely. The poor condition of the lawn could be due to improper management in feeding, watering, mowing, weeding and controlling of pests and diseases. If this is all that is the matter with your lawn, your problems can be solved by proper surface treatments. These operations are discussed a little later on.

Fall is also the best time of the year to begin work in building up a lawn which is already established. Do not start off on the wrong foot by trying to rake off the dead crab grass. Experiments have shown that raking grass often does more harm than good, especially on certain species, such as bluegrass. Gardeners are apt to rake the crab grass vigorously, trying to check or eliminate the growth of this undesirable grass. If all the crab-grass seed could be removed along with the dead leaves and stems, raking would be justified. But this is not possible. Instead of removing crab-grass seeds, raking merely threshes, and a large number of seeds are actually helped to be well planted by this process.

It is true that dead crab grass on the lawn produces unsightly brown patches, but this looks no worse than the bare spots in the lawn that would result if the dead grass were removed. Moreover, the presence of the dead material can be an advantage in reseeding. You can sow your grass seed right into the dead crab grass, which acts

as a moisture-conserving mulch during the winter, thus aiding germination of the seed. By the time the new grass starts to grow rapidly the following spring, the dead crabgrass plants will have practically disintegrated and the soil profits from the resulting addition of organic matter.

Where there are bare spots to reseed, loosen the soil about 2 in. deep and rake the surface to a fine, even texture. As Fig. 18 shows, a household meat tenderizer can be used to prepare the lawn for reseeding. Sow the grass seed evenly and lightly over the thin and bare spots. Then rake the area very gently and tamp the loosened soil down a little with the back of a spade or a tamper. To keep the soil from sticking to the tamper, wrap a piece of burlap around it, as shown in Fig. 19. Whether you are sowing seed into patches of dead crab grass or onto bare spots, this area must be watered thoroughly. Not until germination of the seed is complete should the surface be allowed to become dry again. This will require at least two sprinklings daily.

The addition of plant food is of first importance in improving an established lawn. As has been pointed out before, the natural source of humus in the soil is constantly being exhausted and must be replaced if vegetation is to grow successfully.

A relatively new treatment for grasses is a hormone feeding, which strengthens root systems. Lawns may be watered with hormone solutions during the spring and fall months, using a siphon attachment on the garden hose as in Fig. 20. To assure uniform results by this method it is necessary to apply a given amount of the solution per 1000 sq. ft. This amount, varying with the brand, will be recommended by the manufacturer. Measure the lawn and locate the areas with markers. Then sprinkle uniformly, taking care not to soak or flood the areas. When working on a steep, sodded slope or terrace, keep the bulk of the water on the higher levels as it will seep down the slope. Use a light, spreading spray under low pressure and work on a still day. The two sample sods in Fig. 21, from treated and untreated plots, show the superior root system of the treated specimen. The time interval was the same for both specimens.

There are a number of other plant foods that can be recommended. A complete fertilizer of a 10-5-3 or a 12-6-4 analysis will serve the average lawn. It should be applied at the rate of about 20 to 25 lbs. per 1000 sq. ft. Dump the fertilizer on the lawn in small piles here and there. You can either broadcast the fertilizer with a shovel as in Fig. 22 or spread it with the back of a rake as in Fig. 23. Work the plant food down into the turf with a rake or a stiff broom. Dragging the area with a flexible

FIG. 20
To treat the lawn with a hormone solution, extend a siphon attachment from the bucket containing the solution to the garden hose, as illustrated above, and spray lightly. The lawn should be sprinkled uniformly, taking care not to soak or flood any areas. The operation is best done on a quiet day

The illustrations below show the results of an experiment in which one patch of bluegrass was given the hormone treatment while the other was left alone. The superior root system, seen in the treated grass at the right, will produce better grass over the years
FIG. 21

FIG. 22
An effective way to broadcast top-dressing over the lawn area is with a shovel, as shown above. The plant food is to be distributed as evenly as possible

FIG. 23
The back of an iron rake can also be used to spread the fertilizer, as above. The fertilizer should be dumped on the lawn in small piles here and there

metal door mat is another satisfactory method. Watering the fertilizer into the lawn is the next step.

Ammonium sulphate is a good nitrogen fertilizer to use where the soil is already supplied with phosphorus. It comes in concentrated form and so should be either dissolved in water and sprinkled over the lawn or mixed with a little soil or top-dressing and broadcast over the area. Use about 5 lbs. of ammonium sulphate to 1000 sq. ft. of lawn. If allowed to remain on the grass blades, this fertilizer will cause some injury, so it should be spread just before a rain or washed into the soil with a spray from the hose. If it is not convenient to water the application, the ammonium sulphate or other commercial fertilizer may be scattered when the grass is dry and brushed into the turf with a broom or bamboo rake. Ammonium sulphate is used chiefly because of its quick action. New and vigorous growth can be observed in a lawn 10 days after it has received an application of this fertilizer. This stimulation of growth continues for a month or six weeks and then becomes exhausted. The only disadvantage in the use of ammonium sulphate is the acid condition that develops in the soil if used continually. Also, certain experiments have shown that the use of ammonium sulphate alone has a somewhat harmful effect on bluegrass turf.

Applying fertilizer in the fall encourages the growth of desirable grasses when crab grass and other weeds offer no competition, and this helps to strengthen the turf. In order to produce prompt effect, the fall feed should be in chemical rather than organic form.

Early spring feeding of the lawn is considered the most effective. At this time of the year in many parts of the country the alternate freezing and thawing leaves the soil pitted and honeycombed. This leaves the ground in a perfect condition for the plant food to seep down to the roots where it is needed. If fed just before the final thaw, the lawn won't even require watering to dissolve the plant foods. Spring rains, or tardily melting snows, take the food deep into the ground, encouraging the grass roots to delve down after it. This early root activity before top growth starts assures the lawn of a root system deep enough to sustain it during the hot, dry periods of summer.

If you are not able to get that early spring start in feeding your lawn, it is still not too late to do so later on in the spring. It is advisable to apply plant food before the grass starts to grow, but it is still permissible to feed the lawn after leaf growth has started. Sprinkle the fertilizer on when the grass is dry; then soak the lawn good with a hose or sprinkler to wash the plant food off the grass and into the soil. This is done so that the plant food will not "burn" the grass leaves, a condition which is not actually serious except that it turns the grass brown temporarily. Whenever it is that you apply the fertilizer, see to it that the lawn is cut very short so that the plant food will contact the soil easily. Feeding the lawn in the summer is not advised, because this would encourage the growth of crab grass and other weeds rather than the desirable grasses.

Rolling: An important operation, but one which many gardeners neglect, is rolling the lawn. This process is often overlooked because a roller is an expensive item for the amount of use it gets. Nevertheless, a roller is almost essential in producing a

good lawn. By rolling the established lawn in the spring, you can press back into the soil the grass roots which have been heaved up by the freezing and thawing. This makes for better growth of the grass and smooths the surface at the same time.

The correct time for lawn rolling is just after the frost has left the ground. Then the surface is soft and moist but not wet. Wait until all danger of alternate freezing and thawing is past. Under no circumstances should you roll the lawn when it is too wet, for this is far worse than no rolling at all. The earth should be about the same consistency as it is for spading—a soil that is firm when picked up but will crumble easily when tapped lightly. One rolling in the spring is sufficient for the year. The correct rolling technique is shown in Fig. 24. A soil which tends to be loose and sandy can stand more rolling than a heavy soil. Where the soil is a heavy clay which forms a crust as it dries, rolling may do more harm than good.

The roller should be only heavy enough to firm back any grass which has been heaved up. About 100 lbs. of weight for each foot of roller width is recommended for ordinary use. Either a concrete roller or one of hollow metal half-filled with water or sand will serve the purpose well.

Automobiles backing into grass edges can leave ugly-looking gouges. These can be mended by cutting out the section marred by the gouge in a square or oblong piece. Reverse this section and replace it, as in Fig. 25. This leaves a neat edge on the outside. The damaged section is to be filled in with sifted loam and reseeded with the proper kind of grass seed.

If the ruts in the lawn are not too deep, they can often be removed by the use of a lawn roller, a thick plank and a sledge hammer, as shown in Fig. 26. When the ruts are too deep for this treatment, cut along both edges of the rut with an edge cutter. Roll back the turf in the rut, cutting carefully under it with a spade to loosen it. Then loosen the packed soil underneath, add some topsoil and replace the turf.

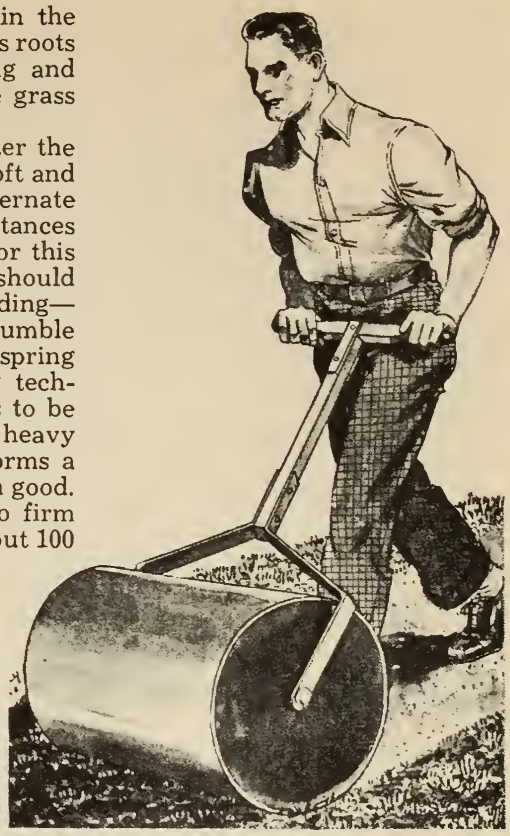


FIG. 24
In rolling a lawn, push the roller firmly in a forward rather than a downward position. Under no circumstances should the lawn be rolled when it is wet

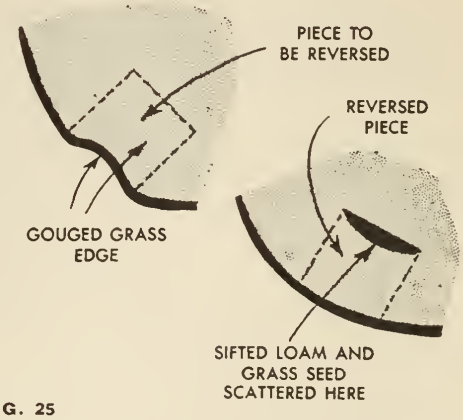


FIG. 25
To mend a gouge at a lawn edge, cut out a square piece of sod, as shown above, and reverse it. Fill in the damaged section with sifted loam and reseed with the same grass mixture as used for the lawn

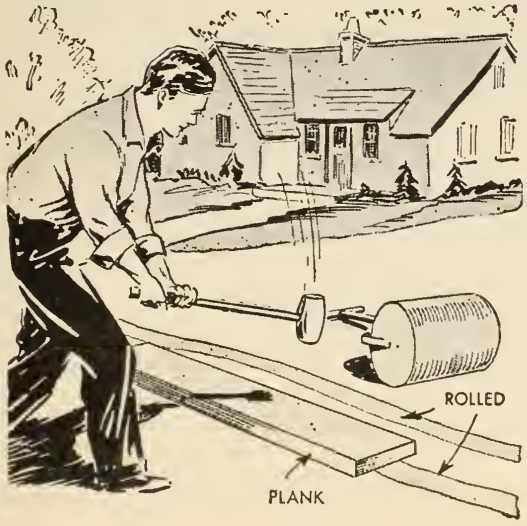


FIG. 26
Ruts made in a lawn by the wheels of a car or truck can be removed without leaving any noticeable trace if the defaced area is rolled to make it compact, after which the ruts are pounded out with a thick plank struck by a sledge hammer as illustrated

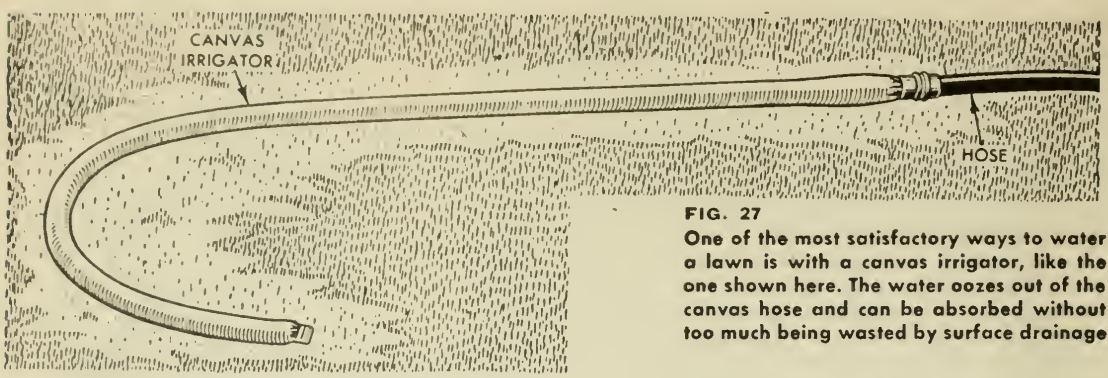


FIG. 27
One of the most satisfactory ways to water a lawn is with a canvas irrigator, like the one shown here. The water oozes out of the canvas hose and can be absorbed without too much being wasted by surface drainage

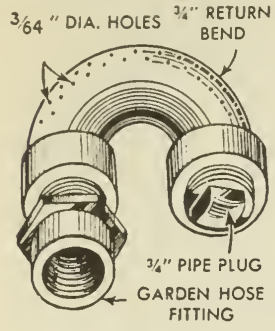


FIG. 28
There is no need to spend a lot of money on a sprinkler, for you can make one yourself if you have the proper equipment. You can improvise such a sprinkler from something as common as a pipe fitting. This can be done by drilling holes, 3/64 in. in diameter, to form the sprinkler head. One end of the pipe is sealed with a ¾-in. plug and the other end is fitted with an attachment for the garden hose

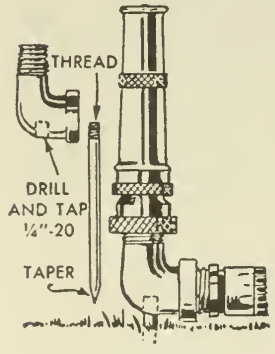
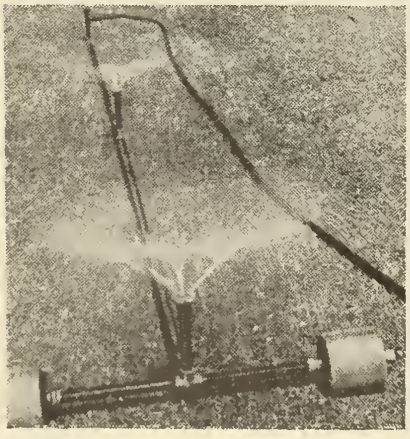
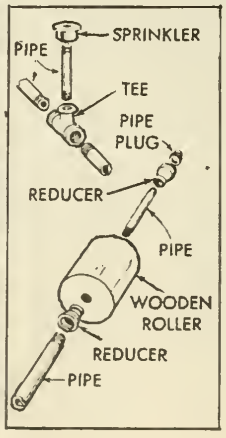


FIG. 29
A nozzle and hose can also serve as a sprinkler with an attachment like the one shown at the left. It is made from a ¾-in. street elbow and a ¼-in. metal rod which serves as a spike. After pointing and threading the rod, drill and tap the elbow as indicated. Then turn the rod into the elbow tightly to insure a leakproof fit. Screw the elbow on the garden hose and attach the nozzle as shown. To use, adjust the nozzle for a fine spray and force spike into ground

Here is a multiple lawn sprinkler which permits the watering of large areas at one time, and the wooden rollers allow it to be moved without damaging the lawn. The unit is assembled from pieces of pipe and standard fittings, and the rollers are turned from wooden blocks. Outlets are spaced at intervals along the length of pipe so the spray will cover the largest possible area
FIG. 30





Lawn Maintenance

Now that you have a new lawn under way or have revived an already established one, you still have a steady job on your hands in taking care of the lawn. This means a proper program of watering, cutting and raking.

Watering: About an inch of water per week is required by most grasses to grow well. If the natural rainfall does not provide for this amount, which is usually the case during the summer in most climates, water has to be applied by artificial means. You can find out when this point has been reached by examining your soil. Using a knife or trowel, cut and dig up a small plug 2 or 3 in. deep. If the upper inch is dry, it is time to start watering. Replacing moisture to an inch or two of surface soil is a simple matter; but if the soil has been allowed to dry much deeper, the task is that much bigger. So don't wait until your grass starts to wilt before you decide to give it some water.

You can water the lawn by means of a sprinkler (Figs. 28, 29 and 30), a canvas hose (Fig. 27) or allowing the water to run *slowly* from the end of a hose. The last mentioned method is not recommended as it takes too long to water a large area properly.

The whole key to proper watering is in the word "soak" rather than "sprinkle." It would not be surprising if a survey revealed that more lawns are spoiled by light sprinkling rather than by drought. As has been pointed out previously, the roots of the desirable grasses delve deep into the ground (with the exception of bent grasses), while crab grass and other weeds are comparatively shallow rooted. It is therefore obvious

that sprinkling the lawn so that the water wets only the upper inch of soil encourages the growth of the undesirable plants while the good grasses do not benefit at all. This is particularly true during the hot, dry midsummer months, during which crab grass and other weeds grow vigorously and such grasses as bluegrass lie dormant. Moreover, if the deep grass roots do not get water, they have to come up to the surface for it. This results in surface rooting, and the first dry spell that comes along can take a heavy toll on the desirable grasses.

The amount of water needed by the lawn will depend on the type of soil in which it is growing. Loam and clay soils retain water well and can keep the grass roots supplied with enough water so that droughts can be withstood. On the other hand, where grass grows in sandy or gravelly soils, the slightest drought dries the soil completely and even weeds may be killed along with the grasses. The exposure of the lawn and the temperature and rainfall also influence the amount of water needed by a lawn. Also closely connected with watering is the height to which the grass is cut. A closely clipped lawn increases the rate of evaporation.

Most home gardeners are apt to resign themselves to a dry, straw-like turf during the hot summer months. It is true that the dormant, dead-looking bluegrass lawn eventually becomes green again when the weather becomes cooler and more moist in the fall. But why not enjoy a lush, green lawn during midsummer when it gives such a soothing effect? This is possible! A glance at golf-course putting greens, which retain their green beauty throughout the summer year after year, is evidence enough that lawns can be kept green even in hot, dry weather. To do this, of course, means a carefully planned watering program plus proper feeding. Don't expect miracles even with the best-planned and most religiously executed watering program *unless* the soil is kept properly fed and healthy. Browning is often caused by diseases, attacks of insect pests and even improper mowing.

In using a sprinkler to water the lawn, allow it to stay in one spot for at least an hour, or even two, or until the water soaks down to a depth of 6 to 8 in. Then move it to another spot for some more sprinkling, and so forth until the entire lawn area is well soaked. This may require as long as four to eight hours and even more, but once the soil is well soaked it won't require another watering for days. The spray of water should be light enough so that the soil can absorb it readily. A fine mist does not work well because it is easily blown by the wind. Neither can a coarse stream be used, because it washes the soil and puts the water

FIG. 31
If you do not keep your garden hose conveniently wound around a reel when not in use, you are probably one of those gardeners whose hose twists annoyingly as it is pulled from the coil. But there is a way that you can prevent this twisting. When you put your hose away, form the hose coils as shown in the detail, laying them one on top of the other. You will note that each succeeding loop is made in the direction opposite that of the previous loop

FIG. 32
To prevent a garden-hose nozzle from becoming nicked or cracked when dropped on a hard surface, pierce a sponge-rubber ball and slip it over the tip of the nozzle. If the hose is accidentally dropped, the ball will keep the nozzle from coming in contact with the concrete pavement

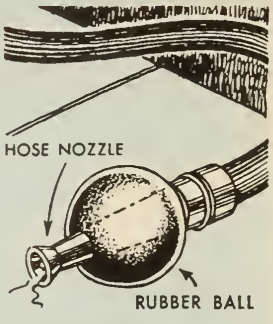


FIG. 33
Repeated kinkings of a garden hose near the faucet connection eventually break the hose and cause a leak. To prevent this, apply a tight spiral wrapping of friction tape around the hose so it extends a foot or so from the connection. Be sure the tape covers the place where the hose kinks

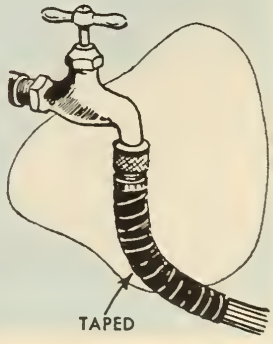


FIG. 35
A length of pipe placed vertically in the ground as illustrated at the left will lead water to tree roots

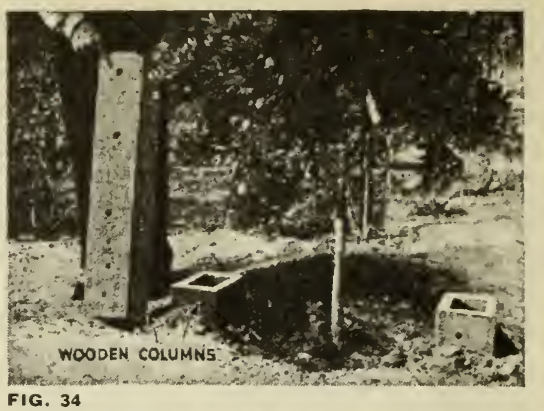


FIG. 34
By supplying water to trees through wooden columns, they will not take as much moisture from other plants

on too fast. If you can get the sprinkler to provide the effect of a slow, easy rain, the water will soak in as it falls and not flood the ground and run off the slopes. In selecting your sprinkler, choose one which is suitable for the size and shape of your lawn. A sprinkler which does not have to be moved too frequently is, of course, the best kind to have. As for caring for your garden hose, Figs. 31, 32 and 33 make a few helpful suggestions.

An automatic underground sprinkler system is a time and labor-saving device which can water a lawn evenly and efficiently. However, even this convenient method can be abused. Because it is so easy to turn on, there is danger of overwatering. This may not harm lawns growing in sandy soils, but too much water in a compact, clay soil can easily drown the grass roots.

Lawns other than bent-grass lawns (see previous discussions) can be watered at any time of the day. It is true that the high temperature of midday causes higher evaporation, thus resulting in waste of water to some extent. Therefore, most people prefer to do their watering in the morning, late afternoon or evening.

There are special problems that arise in lawn watering. The watering of a newly seeded lawn bed requires special attention. Droughts do not harm seed, but germination is hastened by keeping the soil moist.

A problem arises when there is too much water in a compact soil. This often happens when the spring has been too wet. The result is a waterlogged soil in which the deeper roots die because of poor aeration. When this happens the remaining grass depends on the upper surface of soil for its food and water. This activity in the surface soil causes it to dry rapidly, and moisture must be replaced constantly to keep the grass alive. If you nurse the grass along by daily watering with a fine spray, you can urge the roots to go down deeper and the watering can become less frequent. Where grass roots have been weakened by insect attacks, a similar program can be launched to bring the grass back to health.

Tree-shaded lawns also present a problem in watering. Being protected from the sun, these lawns lose less moisture through surface evaporation. But the tree roots draw water from the undersoil, leaving little moisture in it for the grass roots. It's

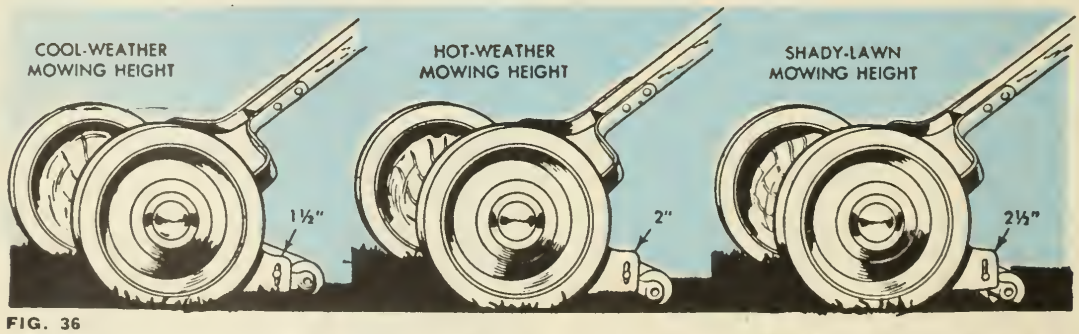


FIG. 36
The height to which you mow the lawn is very important. As shown above, the grass should be kept at a 1½-in. height during cool weather and increased to 2 in. in hot weather. Always keep shady lawns 2½ in. high

a good idea to examine the soil under trees from time to time. If the undersoil is found to be dry, replace the water by slow, penetrating applications. You can also cut down the competition between the trees and the grass for water by providing special means to get a sufficient supply of water to the trees. When a young tree is planted, its roots can be assured of a plentiful supply of water if a length of 6-in. pipe is placed in the hole near the roots, as shown in Fig. 35. The pipe is filled with water, which will be fed directly to the roots instead of seeping through the ground to be absorbed by the soil. Another way to provide a water supply for trees is to sink two wooden columns about 3 ft. into the ground on each side of a small tree, as pictured in Fig. 34. Water is run into the columns and passes into the ground around the tree roots through holes drilled in one side of each column. The holes are covered with screen wire to keep the dirt from falling into the columns.

Mowing: One of the most common mistakes made in mowing is to cut the lawn too short. It must be realized that the grass blades play a vital part in transforming food into energy for growth. By continually cutting off these blades, this function is severely crippled, and the grass has a hard time thriving. On the other hand, if you allow the blades to grow too long, they become spindly and form a thin, weak lawn. There is a happy medium between these two extremes where mowing causes the least injury and yet gives a neat appearance to the lawn. You can attain this medium by cutting the grass to 1 in. in cool weather and raising it to 1½ or 2 in. when the atmosphere becomes warmer and drier. If the turf is kept at this height, frequent cutting will not harm it, and the lawn can be kept uniformly trimmed to give it a well-groomed appearance.

The attractiveness of the lawn is the direct result of high cutting, as it is the grass blades that give the green color to the lawn rather than the yellowish stems which would be exposed were the grass clipped closely. High cutting also has a lasting influence on the general health of the grass. Longer top growth (within reason, of course) means a more extensive root system, which in turn can reach more food and moisture. The blades of grass kept over an inch tall also provide shade to reduce the evaporation of soil moisture.

High cutting is especially important in the case of shaded lawns, where sunlight is limited and the longer growth is needed to help combine air, light and soil nutrients necessary for plant growth. Densely shaded lawns should not be cut shorter than 2½ in., with 3 in. being an even more desirable

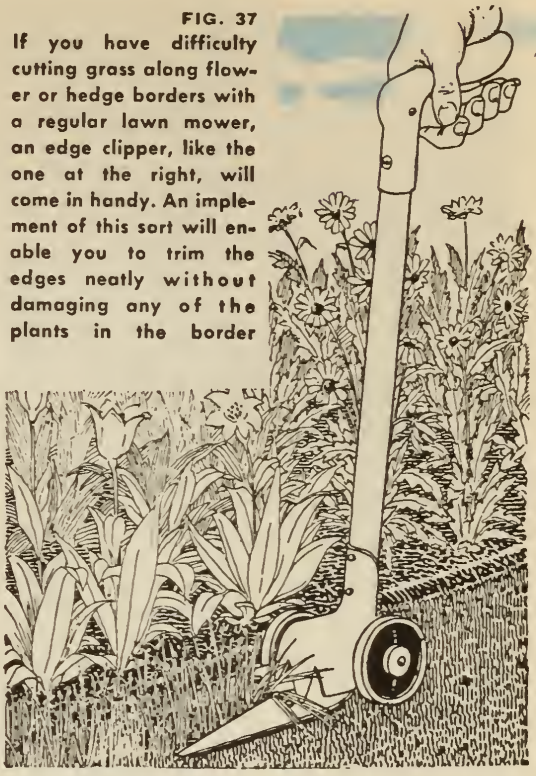


FIG. 37
If you have difficulty cutting grass along flower or hedge borders with a regular lawn mower, an edge clipper, like the one at the right, will come in handy. An implement of this sort will enable you to trim the edges neatly without damaging any of the plants in the border

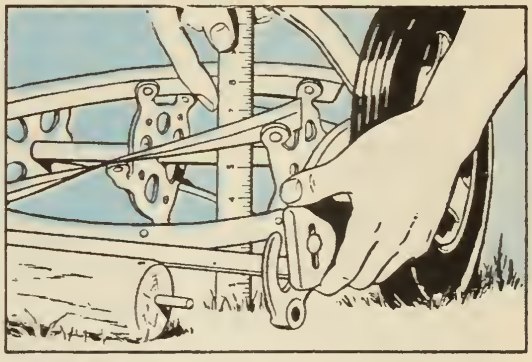


FIG. 38
Measure from the cutting edge of the bedknife to the ground to find out at what height the mower will cut

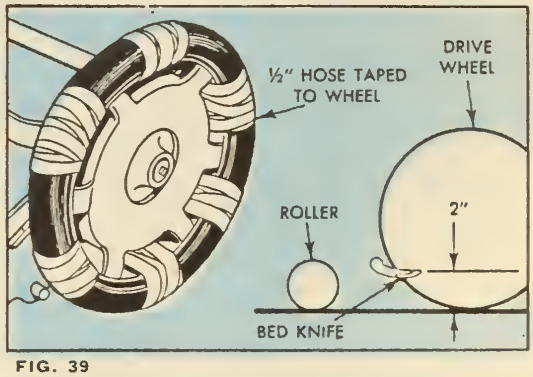


FIG. 39
Wrap a length of hose around the mower wheel, as shown above, if the bedknife cannot be adjusted

FIG. 40
If you cannot adjust the height of the cutter bar on your lawn mower, fit the roller mounting brackets with flat-iron extensions. First, slot and drill two pieces of flat iron as shown in the detail. Then ream the threads out of a small nut and weld it over the hole to serve as a bushing for the roller shaft. The offset in the bracket extensions is bent to suit the length of the roller. Bolting the slotted portions of the extension to the original roller brackets permits the adjustment to be varied to fit seasonal needs

FIG. 41
A broom rake, like the one above, can be used to rake grass clippings off the lawn. In using this kind of a rake, it is often necessary to stop and clean the teeth. This nuisance is overcome and the work speeded if a rubber guard is slipped over the teeth. It is cut from a rubber inner tube and the holes are spaced so they will not spread or pull the teeth together

height. Fig. 36 shows average seasonal mower adjustments.

It often happens that well-fed and well-watered lawns get too thick after a few years of moderately high cutting. In such a situation, mow the lawn fairly close in cool weather, but continue to use the high cut in periods of extreme heat. Bent-grass lawns are the exception to this high-cutting rule. They should be kept at about 1½ in., or better, a 1¾-in. height.

Adjusting the mower so it will cut at the proper height is illustrated in Fig. 38. First place the mower on a flat, hard surface, such as a walk or a garage or basement floor. The next step is to loosen the side brackets at the ends of the roller. As you extend the roller bracket downward, the roller is lowered and the bedknife in front is tilted up. When the cutting edge of the bedknife measures 1½ to 2 in. (or whatever length you are going to cut the grass), tighten the bracket bolts that were previously loosened.

If your mower cannot be adjusted to cut high enough, you will have to obtain longer brackets or extensions (see Fig. 40), from the manufacturer or have them made at a machine shop. Another alternative is to lift the mower wheels by wrapping rubber hose or a ½-in. rope around each wheel rim of the mower (Fig. 39). You can also replace the old wheels with two that have larger diameters.

Naturally, the blades of the mower should be sharp. If not, the grass will be crushed and torn instead of being severed cleanly. Bruising the grass in such a way leaves a brownish cast to the lawn. The time and frequency of mowing are also important. Whether you are to mow twice a week or once a month depends on the condition of the grass and the previous mowing schedule, the rapidity of growth and the weather. If you have mowed to 1½ in., let the grass grow to at least 3 in. before you mow again. If the grass has been cut to ¾ or 1 in., it is better to raise the mower by stages, that is, raise it to 1½ in. and clip the grass a couple of times when it is 2 in. high, then raise to 2 in. and clip when the grass is 3 in. high. Coming into the hot, dry summer months, the frequency of mowings should be determined by the height and condition of the grass and not by intervals of time. In general, it is better to cut too often rather than let the grass get so high that bleached stems are evident after the cutting.

Whether the grass clippings should be removed or not depends on several factors, including your own personal preference. It is interesting to consider the abundant crop produced by grass plants. If you were to save or keep track of all the grass clippings

which come from your lawn in one season, you would find the yield to be something like 36 in. deep. Now this is an immense crop, and one can easily imagine the huge amount of plant food that was taken from the soil by the grass roots and up into the blades to produce this crop. The soil cannot continue to yield so bountifully unless plant food is restored to it.

Grass clippings left on the lawn provide, to a small extent, the needed plant food. These clippings dry out, decay and work their way down into the soil. Besides contributing plant food to the soil, clippings also act as mulch to reduce surface evaporation, thus keeping the soil cooler and more moist.

If the clippings are long, say over an inch, by all means remove them. This can be done either by raking (Fig. 41) or by using a grass catcher when mowing. When the clippings are over an inch long, they do not work their way into the soil readily, and as they dry out they leave a brownish cast to the lawn. Also, if the weather is damp or the outlook is for rainy days ahead, grass clippings should be removed. Damp, heavy clippings will mat down and may cause mold and disease to develop in your lawn.

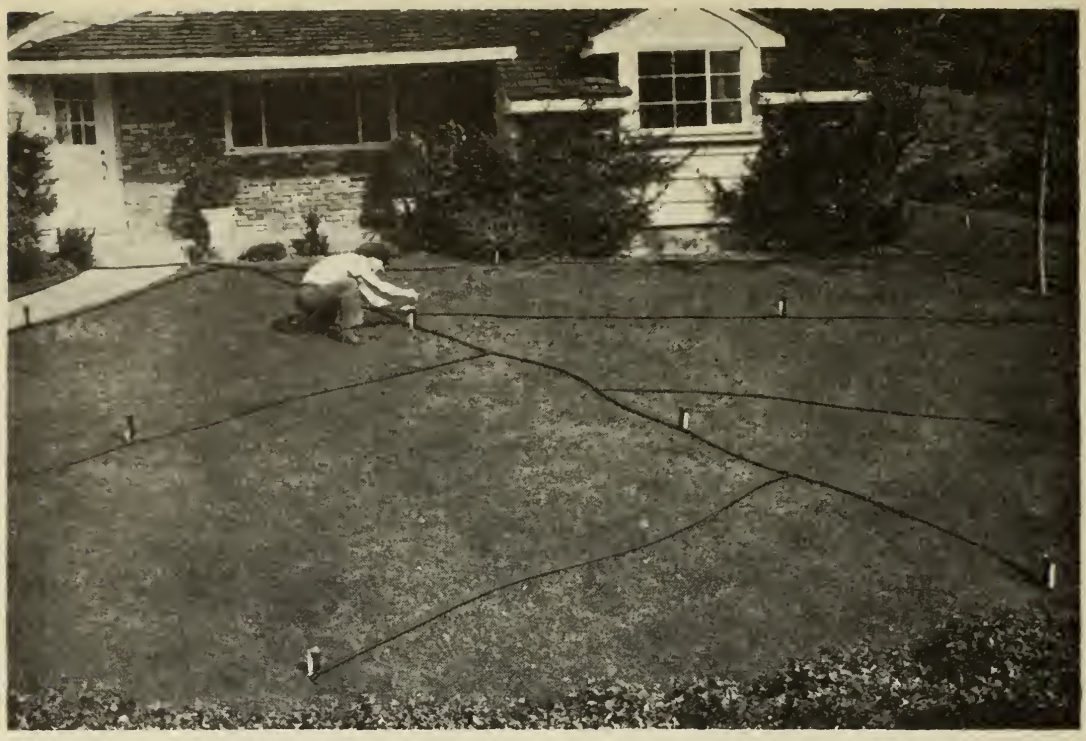
All things considered, removal of clippings from the lawn is of minor importance. Should the clippings lie in strips and make the lawn unsightly, then remove them. Whenever the sight of the clippings is annoying, you can remove them if just for appearance' sake. It is easier to rake away the clippings after they have been on the lawn for a day or two, as they will have decreased in bulk by drying.

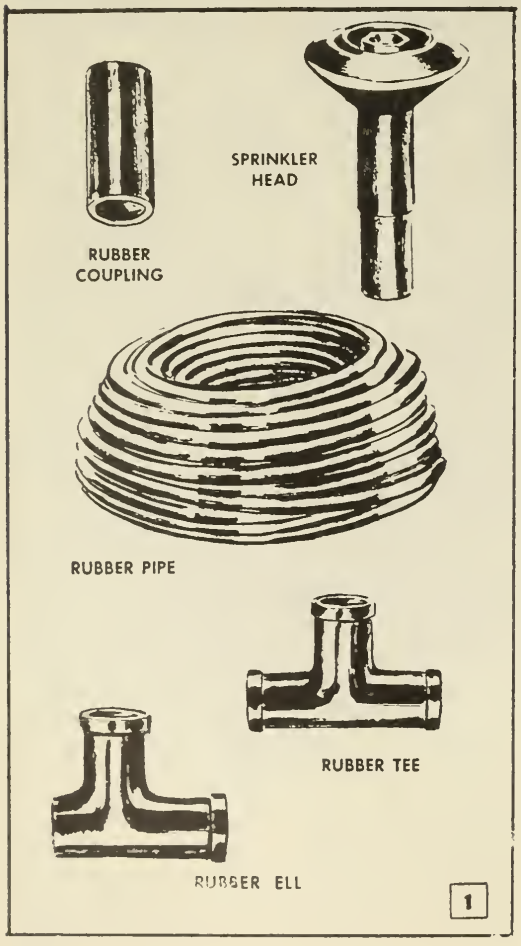
Raking and mulching: Leaves should be raked off the lawn, especially if they tend to form a heavy mat. This is so the grass can be encouraged to grow freely in the fall, and a mat of leaves would hinder growth. Some of the leaves can be raked around shrubbery to act as mulch. The remainder can be piled in some corner of the yard to decompose and form leaf mold, which will be useful later on to improve the garden soil. The excess leaves should, of course, be collected (see Figs. 42 and 43) and destroyed.

A winter mulch on the lawn is unnecessary, and its unsightliness is further reason why it should not be used. However, a light covering of straw can be used to cover a new bed of grass seedlings. This will protect them from being heaved out of the soil by the alternate freezing and thawing that take place in the winter. It is a waste of time to put manure on the lawn during the fall or winter, as the soluble fertilizer elements are leached out and washed away before they can do any good for the soil.

FIG. 42
A gunny sack hung from a circular frame, as illustrated above, is a convenient place to keep leaves until you are ready to burn them. The top of the sack is impaled on six hooks evenly spaced around the rack. When the sack is filled, it can be easily unhooked and carried away to dump its contents

FIG. 43
The wheel frame shown above is the answer to your leaf-hauling problem. The frame is 5 x 7 ft., has wire mesh tacked to the underside of it and two wheels attached to it. Leaves are raked onto the frame in the same manner that dirt is swept onto a dustpan





Put Your

WHAT SOUNDS like a homeowner's dream is a practical, inexpensive underground sprinkling system that can be installed by the homeowner himself over a week end. The system is not damaged by alternate freezing and thawing, and consists of flexible rubber pipe, fittings and rubber sprinkler heads that have brass nozzles. Four types of nozzles are available, Fig. 2, providing spray patterns from a quarter to a full circle.

The first step in installing the system is to make a scale drawing of your property and lay out the system as in Fig. 3. Sprinkler heads spray water in a 7-ft. rad., but should be located only 10 ft. apart to assure an overlap in the spray pattern. A typical plan is shown in Fig. 3. After the plan has been drawn, make a table like Form 1 to determine the volume of water required for your particular system. Normally the volume of water available is insufficient to operate all the sprinkler heads together so the system must be divided into circuits which are controlled by separate valves, Fig. 7.

A quick method of determining the volume of water available at your water meter is to open four or more faucets in the house and count the number of times the cu.-ft. dial on the water meter rotates in 1 min.

Garden Hose Underground

Multiply the number by 7.5 to determine the g.p.m. In some instances, a water meter will read directly in g.p.m. If you do not have a water meter, an alternate method of determining the volume of water available is to use a pressure gauge. Borrow one from your plumber or hardware dealer, fit it into the water line and use the table in Form 2 for converting water pressure into the number of control valves needed for your particular system.

If a ¾-in., or larger, dia. pipe leads to an outside faucet, it may be possible to connect control valves directly to this line. However, if the pipe is small or is rusted inside, it is best to install a separate supply line of ¾ or 1-in. pipe directly to the valves from the meter. The number of control valves required is figured by dividing the volume of water your system requires by the volume of water available. Draw these control valves on your plan, making sure they are in a location convenient for connecting to the supply line and accessible for operation, as well as clear of sprinklers that would wet anyone operating the valves.

If your particular plan results in a circuit that has a line pressure of more than 60 p.s.i., it will be necessary to install a pressure regulator between the meter and the control valves or, when no meter is present, on the pressure side of the control valves. An excess amount of water pressure causes the sprinkler heads to discharge water in a fine spray instead of small droplets. The spray is difficult to control and evaporation is much greater. It is possible, in some instances, to control the pressure to the spray heads by partially closing the control valves. However, this may result in rapid wear of the valve seat and face.

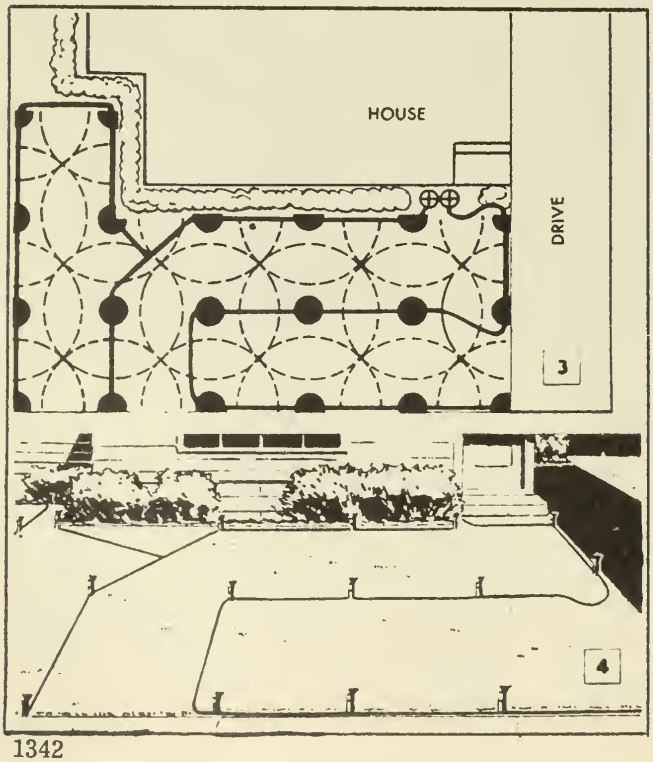
Draw lines on your plan from each control valve so that it connects the correct number of sprinkler heads. After the pipelines have been laid out, recheck the water-volume requirements to make sure that each control valve has to deliver about the same amount of water.

With the system now laid out to scale, you can figure the number of feet of pipe, the number of sprinklers and other fittings needed. To begin the actual installation, set up the control valves as in Fig. 7, using galvanized-steel pipe and fittings. Note that the connections between the steel and rubber pipes must be underground. Also, some provision must be made for draining the valve system during freezing weather. In Fig. 7, a petcock has been installed at the low point of the system. The

full-circle head ● ¾-circle head ◕ ½-circle head ◗ ¼-circle head ◣ control valve ⊕

FORM 1 — TO DETERMINE VOLUME OF WATER REQUIRED

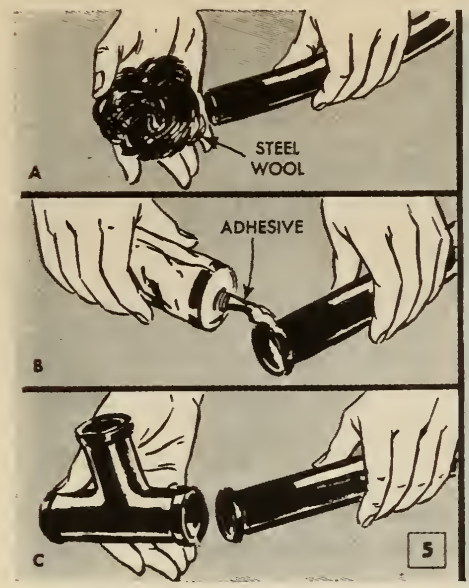
Type of Heads	Number of Heads Needed	Gallons Per Minute Required by Each Type of Head	Total Gallons Per Minute Needed
¼ circle		approx. ½	
½ circle		approx. 1	
¾ circle		approx. 2	
full circle		approx. 2	
Gallons per minute required by system			

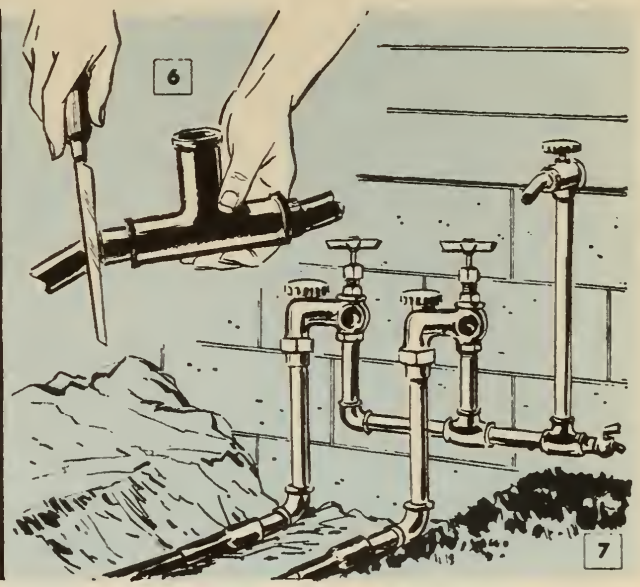


control valves should be the anti-siphon type which in many communities are required by law.

The next step in the installation is to stake out the locations of all the sprinkler heads, Fig. 2, according to your plan. Wire a sprinkler head to each stake, as in the detail in Fig. 2. Now, use a rubber coupling to connect the rubber pipe to the steel pipe at the control-valve connection. Clean the end of the steel pipe back about 2½ in. with steel wool or sandpaper, apply a ring of adhesive around the end and slip on the rubber coupling, forcing it over the pipe for the full 2½ in.

It may be necessary to warm the coupling in hot water for about 15 min. so that it will slip over the steel pipe more readily. Next, rough up the end of the rubber pipe, apply a ring of adhesive and force the pipe into the coupling until it contacts the end of the steel pipe. Unroll the rubber pipe to the first sprinkler head, cut off the pipe and connect it to the first tee as indicated in details A, B and C in Fig. 5. Repeat this operation on the opposite side of the tee and fit the sprinkler-head-and-riser combination into the tee, making sure the nozzle in the head is facing in the proper direction. Do not cement the sprinklers to the tees as yet. In some instances it may be desirable to run a single line of smaller-dia. pipe to locate a sprinkler some distance from the main group. To effect a size

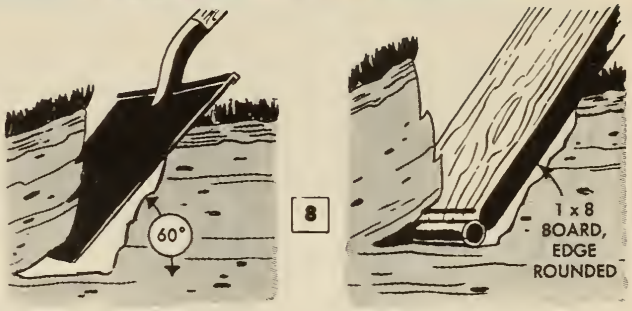




reduction in rubber pipe, for example from ¾ to ½ in., cement a length of ¾-in. pipe in the ¾-in. fitting and cut it off so that about ¼ in. projects. Then insert the ½-in. pipe inside the projecting ¾-in. pipe. Reduction from 1 in. to ¾ in. is done in the same manner.

Continue unrolling the pipe and connecting the sprinklers until the job is complete, Fig. 4. Now, test the system by opening a control valve until the spray from each head is about 15 in. in diameter. Adjust the screw in the middle of each nozzle so all heads have an equal spray radius. Finally, open the control valve all the way and check for complete coverage. Repeat the procedure for each circuit in the system.

To bury the system, turn on the water in the circuit you wish to work on first and let it soak the ground for about 45 min. or until a spade can be inserted in the ground easily to a depth of 4 to 6 in. Start at the control valve and cut the sod on a line extending a couple of feet past the first sprinkler head. Next, push the spade into the ground at a slight angle for about an inch and pry back, Fig. 8. Repeat this until the slit is 5 or 6 in. deep. At the location of the sprinkler head the slit should be vertical. Cut out a circle of sod for the sprinkler head. Start at the control valve again and insert the rubber pipe, using the rounded end of a length of 1 x 8, Fig. 8. At the sprinkler head make sure the head fits flush with the ground. If it cannot be set deeper, cut off a portion of the riser. Now, remove the riser from the tee, wipe dry, rough with sandpaper, apply cement and reinsert in the fitting. Do not cement the last head in the circuit until all the fittings and pipe have been buried. Then remove the last head, turn on the water and allow it to flush all foreign matter out of the system.



FORM 2 — NUMBER OF CONTROL VALVES NEEDED AT VARIOUS PRESSURES

1 Control Valve Serves: No. full-circle heads (spacing—approx. 10')				1 Control Valve Serves: No. half-circle heads (spacing—approx. 10')			
Line Pressure	½" pipe	¾" pipe	1" pipe	Line Pressure	½" pipe	¾" pipe	1" pipe
30-lb.	4	6	14	30-lb.	7	10	25
40-lb.	5	8	17	40-lb.	9	15	32
50-lb.	6	10	20	50-lb.	11	18	36
60-lb.	7	12	23	60-lb.	13	23	42

Finally, start at the control valve and tamp the sod into place. Repeat the above operations with the other circuits. The directions of the spray head of fractional heads are given a final adjustment by turning the brass nozzles with a wrench. When separate circuits are installed to cover flower beds, make sure they are located so they will not be disturbed when the flowers are cultivated. ★ ★ ★

July is the month when tempers grow short, curses grow long and many a homeowner vows he'll plow up his lawn and start anew. It's the pivot point of summer, the moment when crab grass lifts its tousled head, looks around, then reaches out its hairy arms to embrace succulent lawns across at least two thirds of the country.

The harried homeowner is always on the prowl for new weapons to aid him in his desperate battle against this ancient enemy. Many a man has given his lawn a one-shot treatment of a new chemical in the hope that at last he has found the ultimate weapon. Alas, the Creeping Plague reaches out to smother his lawn again.

Can crab grass be killed?

SMOOTH CRAB GRASS is reddish at base, has yellow-green seedlings that branch out and root at the joints

Yes. With the aid of a wide range of new chemical killers you can rid your lawn of this pest.

But you can't achieve victory with one treatment, or even in one year. The secret of winning the battle is an attack that goes on around the calendar for at least two years, perhaps longer.

The work isn't hard. It merely means spreading a dry chemical or spraying a wet chemical on your lawn at the right time and in the right amount.

But you must be persistent. Outlined below is a 'round-the-calendar program.

To learn why you must keep at the job, take a good look at your enemy. Crab grass is an annual; that is, new plants develop each year, not from the old ones, but from seeds dropped by the old ones. Thus it is a waste of time to kill a crab-grass plant *after it has formed seed heads.*

Large-area sprayer can cover a lawn completely with a liquid-type crab-grass killer in short order

Better Lawn & Turf Institute photo

HAIRY CRAB GRASS has larger, hairier leaves that are more gray-green in color; is more difficult to kill

Better Lawn & Turf Institute photo

One-wheel sprayer totes a two-gallon tank that can be filled with crab-grass chemical. Below, killers are also available in dry form for hopper spreaders

O.M. Scott and Sons photo

Once seed heads form, they ripen even though the plants are killed.

The U.S. Department of Agriculture says: "The key to success is to prevent plants from setting viable seed that will produce another infestation, the following season."

The seeds may spring to life any time from late spring until the first frost. Furthermore they may lie dormant for a year or two before they suddenly awaken.

There are two major species of crab grass, as shown, pages 1344-1345. As you might suspect, the larger, hairier variety is the more difficult to kill. The two varieties go under several aliases in various parts of the country, but regardless of what these public enemies are called, they're still crab grass.

Killer chemicals can't do the job alone. The best deterrent to crab grass is a thick, vigorous turf. Reseed bare spots and feed your lawn at regular intervals. Crab grass thrives in the sun, so set your mower to cut high, thus providing shade at the soil level to discourage crab-grass seedlings. During dry spells it's much better to water your lawn deeply once in a while than to sprinkle it lightly every day.

In applying the new chemical killers, one factor is most important. *Follow the directions precisely!* Different formulations of the same chemicals are available, and must be applied in different strengths. You can be sure of doing the least damage to your lawn and the greatest damage to crab grass only if you follow directions. Measure off a small part of your lawn and test the coverage on this area first.

Several different types of chemical killers are available, but they all fall into two categories. *Post-emergent* chemicals kill crab-grass plants. *Pre-emergent* chemicals kill the seed. The pre-emergent types are relatively new, and make possible a year-round control campaign.

Trade names of these products usually give no indication of the chemical compound inside the package. Federal law, however, requires that the label state the formulation. By comparing that statement with the chemical names given below, you can be sure of the type of killer inside the package.

Obviously there's no need to use all the chemicals on the following list. Use of one good pre-emergent and one good post-emergent killer each year for two or more years should do the job.

Here's a roundup of several of the crab-grass killers. They are listed on a calendar basis so you can plan your own year-round campaign.

Midsummer

This is the season of fast growth, when the plants begin to form seed heads. One killer for this time of year is *KOCN* (*potassium cyanate*). Research has shown, according to the U.S. Department of Agriculture, that a small amount of 2,4-D (ordinary broad-leaf weed killer) added to KOCN will increase its effectiveness.

Another midsummer weapon is AMA (amine methyl arsenate). It can be applied any time during the growing season. Usually two or more applications, five to seven days apart, are required.

This is the time for effective pre-emergent controls. Here are a few:

Calcium arsenate. Get this stuff on early, before the first crab-grass seed cracks its coat. One authority recommends applying it at the rate of 12 pounds per 1000 square feet, immediately after the last snow thaws (but how do you know which is the last snow?). In any event, there's no need to wait until the ground thaws completely. According to another expert, you can apply calcium arsenate up until the day the first daffodil blooms. If you apply it earlier, during a February thaw, it can also provide excellent control for knotweed. The second year, authorities recommend a booster application of about one fourth the dose of the first year. This, they say, should give up to 95 percent control. Calcium arsenate is poisonous, so keep it away from children and pets. Once it is on the soil, however, it is safe.

Chlordane. This chemical provides a one-two punch, but must be handled more carefully than some of the others. It should be applied in early spring, well before the first seedlings emerge, at the rate of four ounces of 45 percent chlordane emulsion per 1000 square feet. In addition to crab grass, it also destroys many soil insects including grubs. Warning: Do not apply to a relatively new lawn.

Triazine complex. This is designed for use in the South for pre-emergent control of many weeds, including crab grass. It should never be applied to a newly seeded lawn. Use it only on Bermuda and St. Augustine grasses.

Early Summer

PMA (phenyl mercuric acetate). This chemical kills crab-grass seedlings as soon as they emerge but before they advance to the seed-head stage. Three to five treatments at intervals of seven to ten days usually are necessary. PMA may be applied any time between the emergence of the crab grass and the two-leaf stage.

Disodium monomethyl arsenate. This is another early summer control. It should be repeated once or twice at 10-day intervals. It browns lawn grasses severely, but causes no permanent damage.

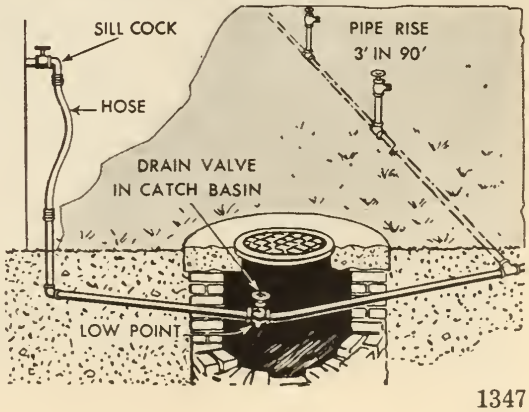
Once you start your year-round campaign, don't forget that persistence is the secret of success. You can't apply any chemical only once and expect to rid the lawn of your ancient enemy. But careful use of pre-emergent and post-emergent killers can bring ultimate victory. ★ ★ ★

Prevent Sloping Lawn Erosion

Pieces of broken draintile were found by one homeowner to be excellent for holding the soil on sloping ground. The porous tile also serves as a "mulch" to retain moisture, which aids in the rapid growth of ivy and other ground cover suitable for binding the soil and preventing it from eroding. The curved pieces of tile are not moved easily and provide stepping stones when the ground is muddy. When soil is worked in around them, the tiles are not unsightly, and soon are covered with plants that conceal them completely. If desired, the tile pieces may be worked into a design.

Nonfreezing Sprinkling System Drains Into Catch Basin

While underground lawn-sprinkling systems save a lot of work, it is difficult to keep them from freezing in the winter. However, a system such as the one illustrated is equipped with a valve that permits draining the water from the entire system into a catch basin. This is made possible by laying the pipe on a rise of approximately 3 ft. in 90 ft. and locating the drain at the low point in the line. If there is no catch basin in your yard, a small one can be built by digging a hole of suitable depth, filling it about a third of the way with crushed rock and walling the upper portion of the hole with brick.



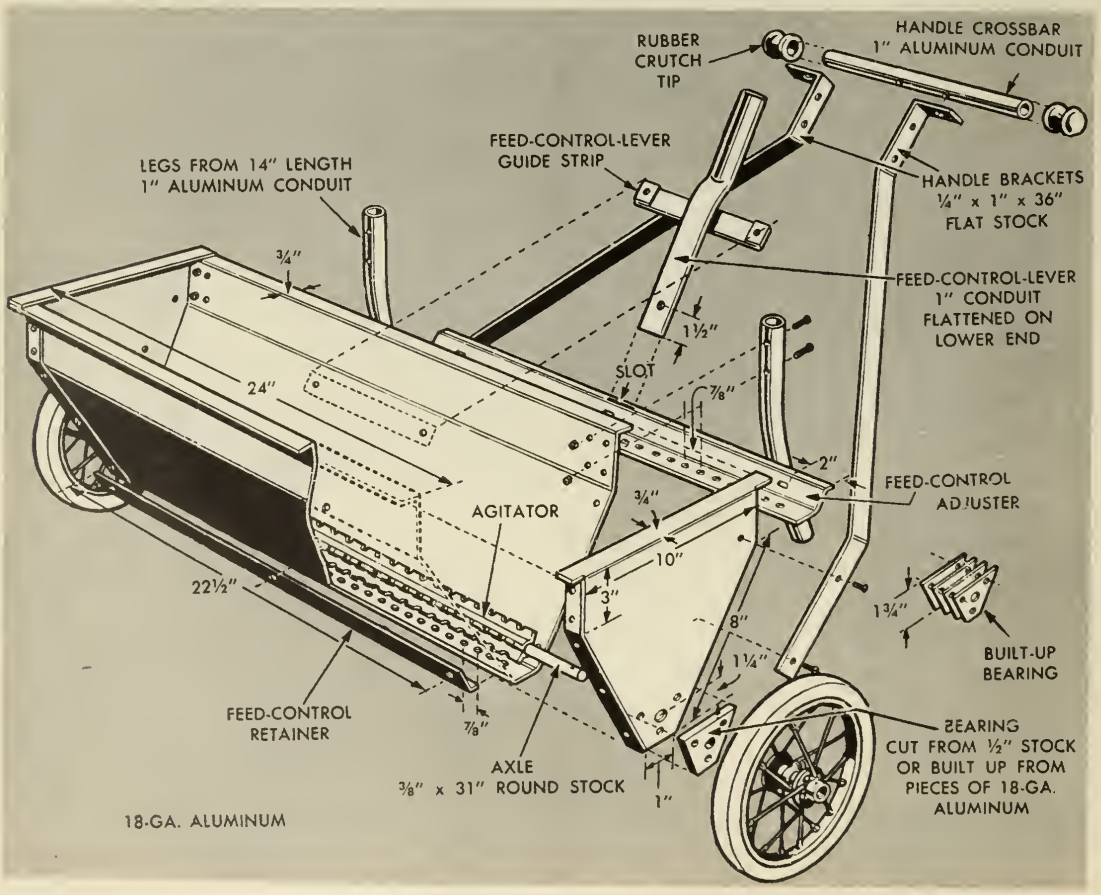
Lightweight Seeder-Spreader

MADE MOSTLY of aluminum, this lawn seeder and fertilizer spreader is lightweight, rugged and has fairly large capacity. Wheels for the seeder can be from a discarded baby buggy, tricycle or other small-wheeled vehicle. An axle of ⅜-in. dia. is shown in the detail, but this dimension can be changed to suit the wheels.

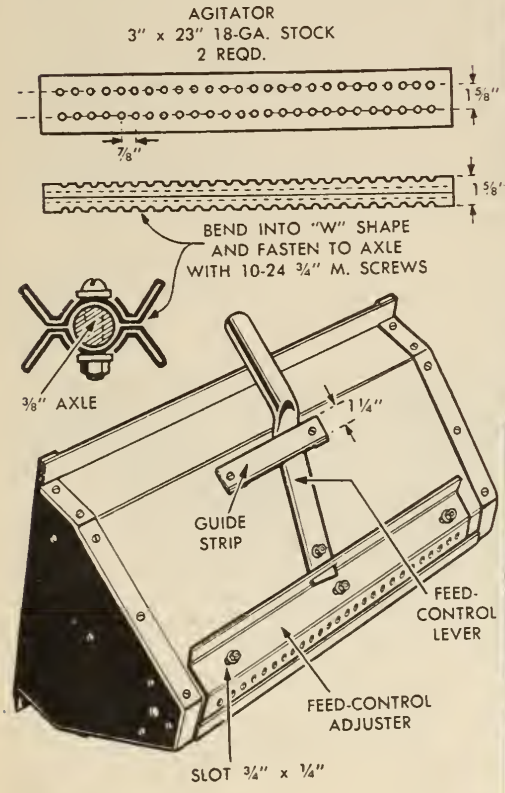
Two ends and the body of the seeder are cut and bent from 18-ga. sheet aluminum, with a ¾-in. flange being bent on the edges of the end pieces and along the long edges of the body as shown in the details. The feed-control adjustment consists of an aluminum strip 2½ x 22½ in. long. Holes are drilled in this strip ⅜ in. in dia. and spaced ⅞ in. apart, 7/16 in. from one edge. A bend then is made in this strip ⅞ in. from the same edge, the angle matching that of the bottom of the feeder body. The opposite edge is bent in the opposite direction to provide a ½-in. flange, in which a slot is cut to accommodate the end of the feed-control lever. Three slots, ¼ x ¾ in., are cut in the bent strip so it can be moved back and forth on three machine screws on the seeder body as indicated in the right-hand detail. After attaching the feed-control adjuster strip to the seeder body, move it to the "open" position and drill through the holes to provide corresponding holes in the bottom of the seeder body. An L-shaped strip now is bent and attached to the lower edge of the body front so that it supports the edge of the feeder control.

The agitator for the seeder is made from two 3 x 23-in. strips of 18-ga. aluminum, drilled and folded as indicated in the detail, then bent to a W-shape and screwed to the axle. Bearings for the axle are cut from ½-in. stock or built up from pieces of 18-ga. aluminum. The feed-control adjustment lever is a 12-in. length of 1-in. aluminum tubing that is hammered flat for all but 5 in. of its length. The 1¼-in. lever guide strip is shimmed at the ends.

Hold a metal scriber against the lever and swing it so the feed-adjustment goes from full-open to closed, and scribe an arc on the feeder body. Divide this arc into five



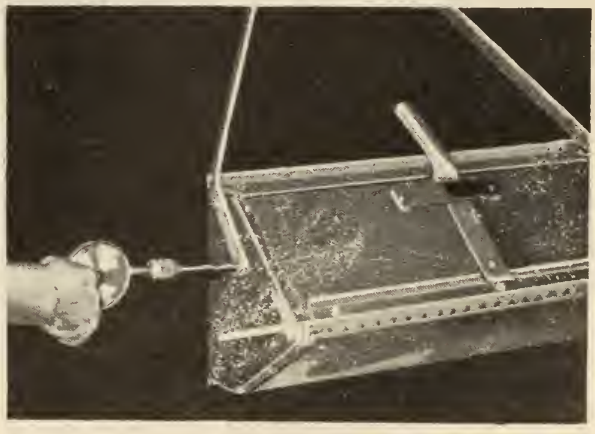
sections so that the feed-control table included in this article can be used to adjust the seeder to discharge the correct amount of material, whether it be seed, fertilizer or top dressing. When attaching the handle, which is shaped from aluminum flats, first drill the top holes in the body for the handle, then try various angles to determine a comfortable height before drilling the lower holes. ★ ★ ★



FEED-CONTROL TABLE

HOLE OPENING	GRASS SEED 1000 SQ. FT.	COMMERCIAL FERTILIZER 100 SQ. FT.	SALT, TOP DRESSING, LIME, ETC.
1/5	2 LB.	1 LB.	USE WIDE OPEN
2/5	2½	2	
3/5	3	3	
4/5	5	4	
5/5	10	5	

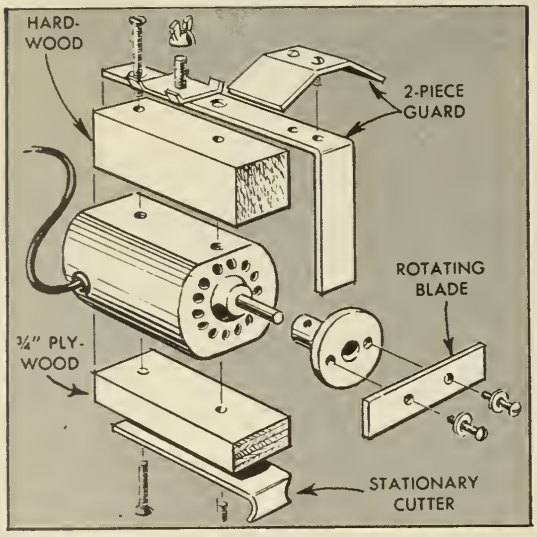
Feed-control table above shows different feed adjustments to be made for distributing various types of materials with the spreader. Below, upper hole for attaching handle is drilled first, then handle position is checked for height before drilling the lower holes in the seeder ends



Make This Electric LAWN TRIMMER-EDGER

HERE IS an electric lawn trimmer-edger that you can make in a few hours out of an old sewing-machine motor or other small motor, a few pieces of wood and metal and a trimmer blade. The only item that need be purchased is the blade. The handle was fabricated from a length of thin-wall conduit in which the wires that supply current to the motor are inserted. A bolt and wing nut, used to attach the handle, allow the unit to be held in two positions—one for trimming around shrubs or next to walls or fences as shown below, and one for edging a lawn around sidewalks or stepping stones as shown in the illustration at left.

The stationary cutter, as detailed in the drawing, forces grass away from the sidewalk and into the blade for a better job of edging. It also serves as a spacer for obtaining a uniform edge around the lawn while preventing the blade from striking the sidewalk or other object around which the lawn is being trimmed. The two-piece guard is made of ⅛-in. flat steel and serves the dual purpose of protecting the operator from flying debris that might be thrown by the whirling blade, and functions as a retainer to prevent the blade assembly from flying off its shaft should the blade come loose.



Handle, secured to machine by bolt and wing nut, used in normal position, above, when edging lawn, reversed when unit is used as trimmer, below. Guard prevents contact between blade and other objects

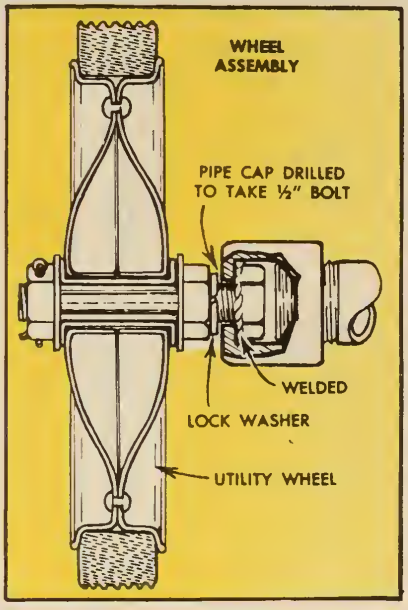
LAWN SPRINKLER CADDY

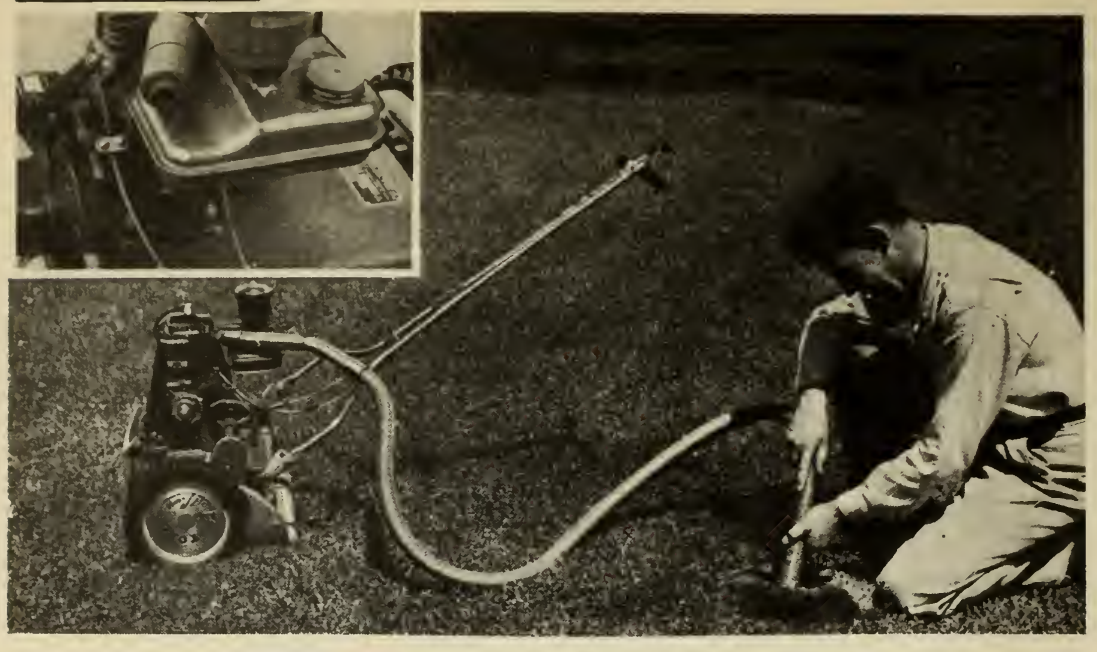
By Fred Haitz

KEEPING A large lawn watered properly during a "dry spell" is much less of a chore when you have a lawn sprinkler caddy like the one shown. It waters a large section at one time, is easy to move and is made of ¾-in. steel pipe and fittings to which hose nozzles are attached as indicated in the photo, below left. The nozzles permit complete adjustment of spray—from large volume, coarse droplets for quick saturation, to a fine mist that is ideal for watering seedlings and slow soaking.

Each of the caddy wheels is mounted on a bolt welded to an assembly consisting of a pipe cap, nipple and tee fitting installed at one end as in the photo, below right, and the drawing. If two wheels and a shaft are available from a discarded tricycle or coaster wagon, the shaft may be installed in the above assembly instead of welding a bolt to each of the pipe caps as suggested. This will save a welding job. Wheel bearings should be well-greased to prevent corrosion.

When not in use during the watering season, the caddy stores inconspicuously next to a fence or along the edge of a flower bed. For compact winter storage, it may be disassembled into easy-to-handle sections.





An old vacuum-cleaner hose attached to the engine's muffler can conduct deadly fumes to rodent's burrow

Use the Engine for Other Jobs

THE ENGINE on your power lawn mower probably will deteriorate as much from lack of use as from wear, so why not put it to extra work turning a concrete mixer, sawing wood, running a paint sprayer and other jobs before the day of trading the mower in on a new model? Most reel-type mowers can be adapted for use with the accessories illustrated in this article. To mount some of the accessories and also to use the mower as a light hand truck, it is necessary to provide a simple platform such as the one shown in the detail on page 1354.

Engine Exhaust Kills Rodents

One of the simplest attachments for your mower is one that can be used to exterminate burrowing rodents. If an old vacuum-cleaner hose is available, cut several 2-in. slits in one end of its metal fitting so that the latter can be slipped over the exhaust pipe. Connect the hose to the end of the tube, place its other end in the entrance to a rodent's burrow and idle the engine for three to five minutes.

Mower Headlight

A headlight is another handy accessory to have on a mower for anyone who must cut his lawn after dark. For the necessary current to operate the light, mount a bicycle generator on the engine platform so that its drive wheel will bear against the mower's V-belt. The generator can be attached permanently by providing a two-position bracket that allows the generator to be pushed away from the belt when the light is not in use.

Operates Paint Sprayer

A small air compressor of the diaphragm type can be attached to your mower for those occasional painting jobs or for applying certain types of insecticides. In addition to saving the cost of an electric motor, this installation will permit you to use a spray gun away from an electrical outlet. When a considerable volume of air is required, an air tank can be attached to the air hose between the compressor and the gun to supply the needed reserve.

Drainage and Fire Pump

For a handy portable pump that can be used to drain a flooded basement, for irrigation, and many farm uses, mount a low-pressure big-volume centrifugal pump

Friction-driven by V-belt, bicycle generator provides current for headlight

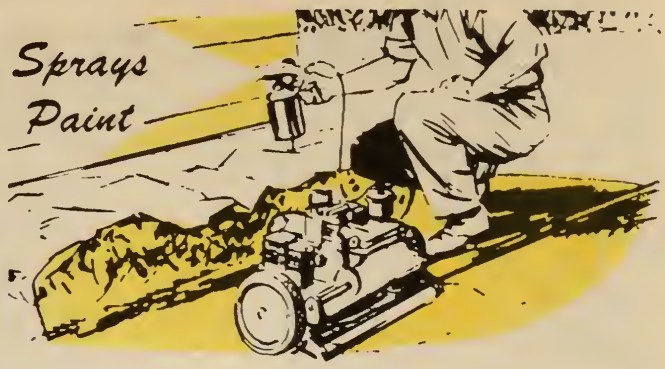
on the platform. A V-belt drive can be used, with the pump pulley about the same size as the one on the engine to give proper operating speeds. The pump can be removed when not in use.

If you would like to have some emergency fire protection handy, mount a small, high-pressure centrifugal pump on the mower so that a V-belt can be slipped on its pulley at a moment's notice. Garden-hose couplings should be fastened to the outlet and intake on the pump to permit quick connection of your garden hose in the event of a fire.

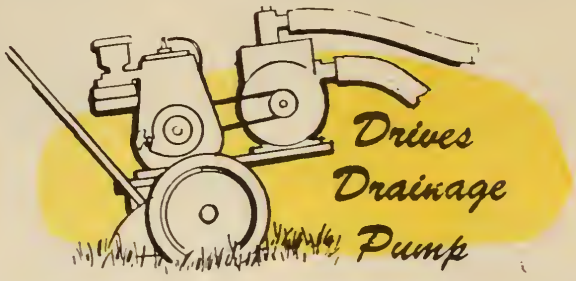
Operates Generator

A variety of power equipment can be operated when a 110-volt a.c. generator is attached to your mower. This accessory will permit you to use electric hedge clippers, sprayer, small power tools, etc., where no electrical outlet is available. A 600-watt generator is the maximum size that should be used with the average small lawn-mower engine.

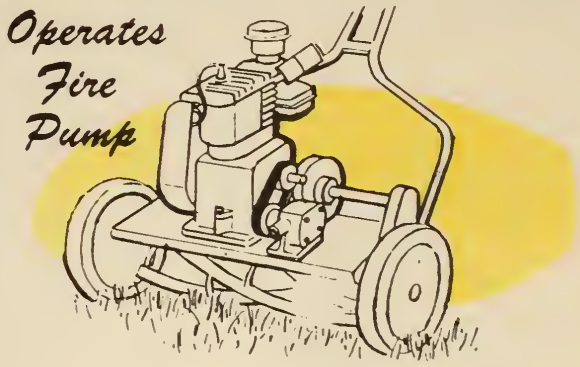
For recharging auto batteries it is only necessary to replace the 110-volt generator with a used auto generator. The latter



Paint-sprayer compressor mounted on engine platform supplies spray gun with sufficient pressure, saves cost of an electric motor

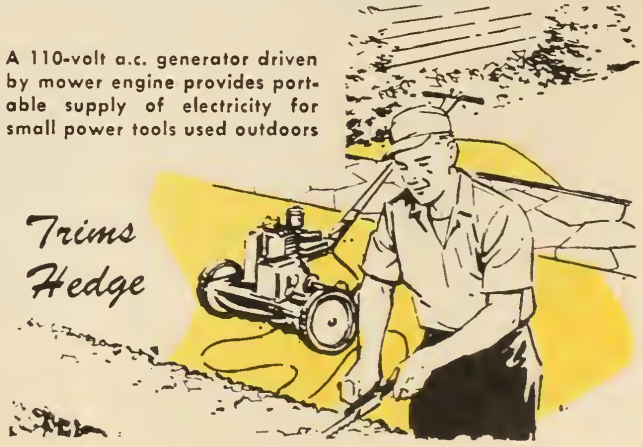


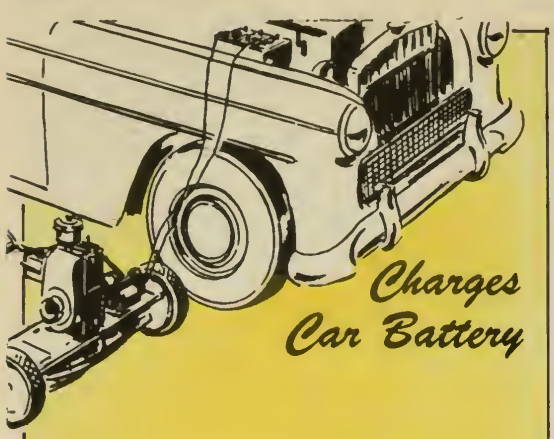
Attach drainage pump to a demountable, plywood platform for a handy unit that is easy to move to window of flooded basement

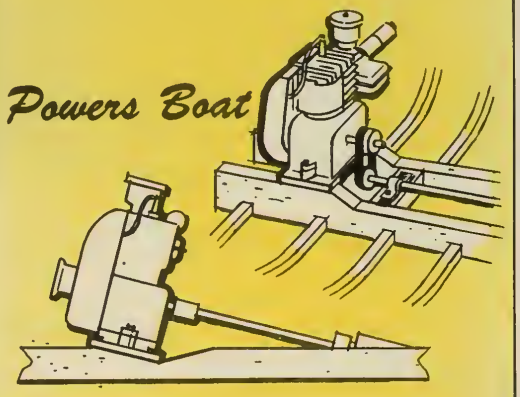


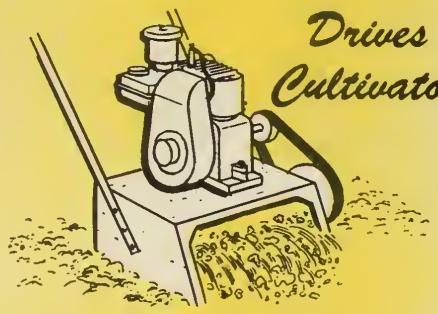
Small, high-pressure centrifugal pump with garden-hose fittings is mounted on engine platform for emergency fire-protection use

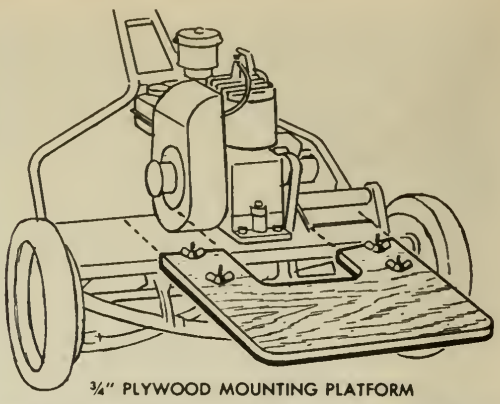
A 110-volt a.c. generator driven by mower engine provides portable supply of electricity for small power tools used outdoors











¾" PLYWOOD MOUNTING PLATFORM

Attach a piece of plywood to engine platform and you have a practical hand truck for light loads

can also be used to provide current for lighting away from an electrical source by rigging several auto headlights on extension cords.

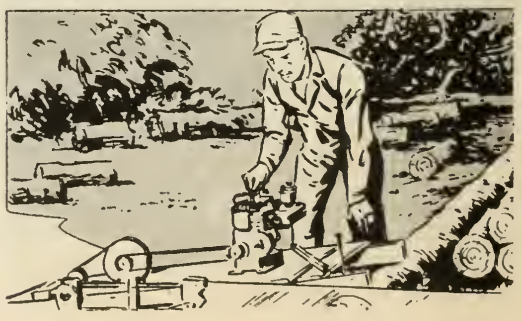
Detached Uses

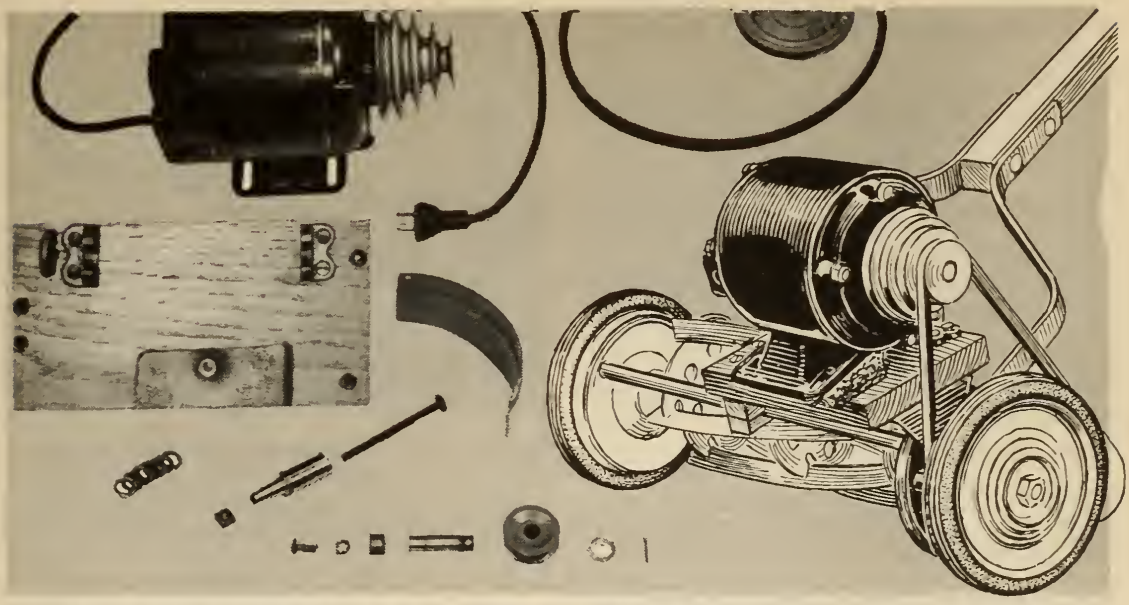
Most reel-type mower engines can be removed from their platforms in a few minutes and used to power other equipment while the mower is not in use. Mounted on engine stringers in the stern of a rowboat or sailboat and fitted with a shaft, shaft box and propeller, the engine can provide ample auxiliary power. If you are a mechanic at heart and wish to build your own garden cultivator, the mower engine is a natural for powering it. A suburban dweller or farmer with a wood lot can put the engine to work powering a dragsaw or circle saw.

Many home-size concrete mixers are available without motors. Your mower engine will easily handle a 3½-cu.-ft.-capacity mixer, when it is mounted on a plywood platform on the mixer frame.

A sickle bar and a power edger are available for some reel-type mowers. Power for the sickle bar is transmitted by means of an eccentric wheel bolted to one end of the mower reel. ★ ★ ★

Mounted on a special wooden platform a mower engine can be used to power a small cordwood saw

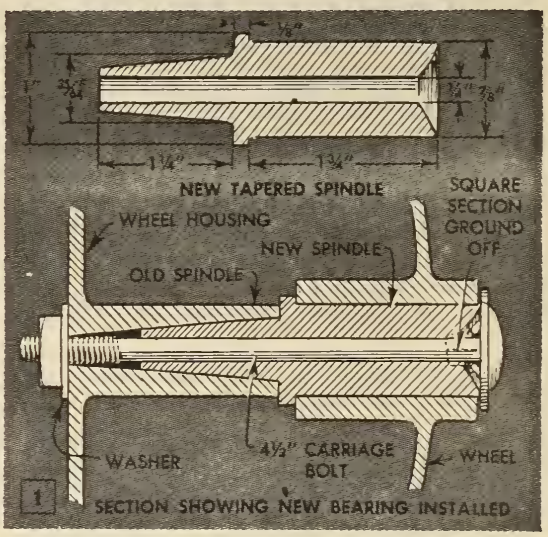




THESE FEW PARTS WILL MOTORIZE YOUR MOWER

By Harry L. Truchelut

WANT TO TAKE some of the "push" out of your hand mower? You can do it easily with a ⅓-hp. electric motor and a few odd parts. Basically, the job consists of extending the original axle of one wheel to provide pulley clearance, fitting a V-pulley to the blade shaft, adding an idler pulley to the mower-wheel housing and providing a wooden platform for the motor. Fig. 1 shows how a tapered spindle extension is machined to fit into the old axle. The distance between the shouldered section and the outer end of the spindle should be 1/32 in. longer than the length of the wheel bearing. The general dimensions given are specifically for an 18-in. Savage (35) mower and it may be necessary to modify them to suit



After removing wheels from mower, pinions and pawls are removed from ends of blade axle. These parts are not needed. Right-hand wheel is replaced

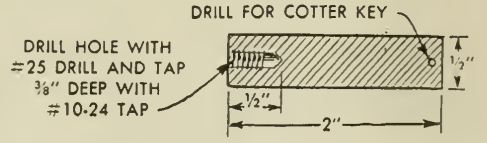
The degree of internal taper in wheel spindle is measured with cardboard template and then new extension spindle is turned to seat accurately in hole

the particular type of mower at hand.

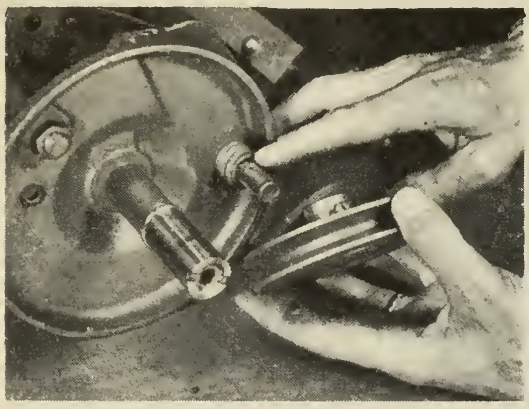
Both wheels must first be removed from the mower so the pinions and the pawls on the blade shaft can be removed and discarded. The right-hand wheel is now replaced. A 4-in. V-pulley with a ½-in. hole takes the place of the pinion in the left-hand wheel. You may find it necessary to ream the pulley slightly to make it fit the shaft. The pulley is locked to the shaft with a setscrew bearing on a flat. The latter is formed on the shaft with the edge of a flat file. Washers are placed behind the pulley to keep grass clippings out of the ball bearings.

Fig. 2 details the idler assembly. It consists primarily of a 2-in. V-pulley rotating on a ½-in. stub shaft to track freely with the 4-in. V-pulley. A 2-in. V-pulley on a 1725-r.p.m. motor will give a cutting speed of about 860 r.p.m. The end of the idler

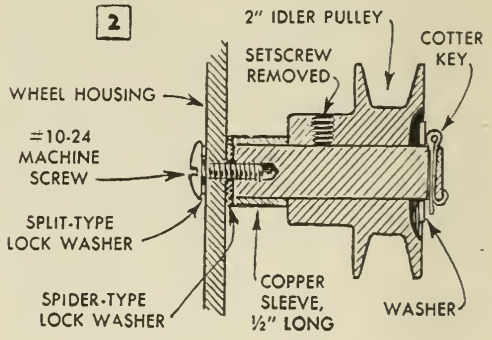
Left-hand wheel spindle is extended to provide clearance for pulleys. New extension shaft is turned from steel to fit tapered bore of spindle. Long carriage bolt holds both extension shaft and mower wheel to housing. Shouldered portion of spindle must fit wheel



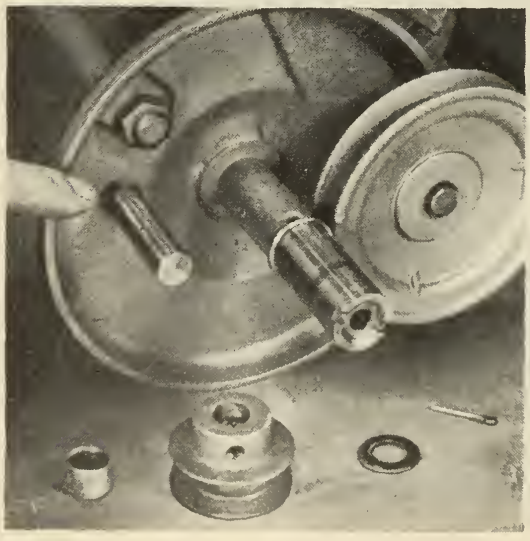
SECTION THROUGH IDLER-PULLEY SPINDLE



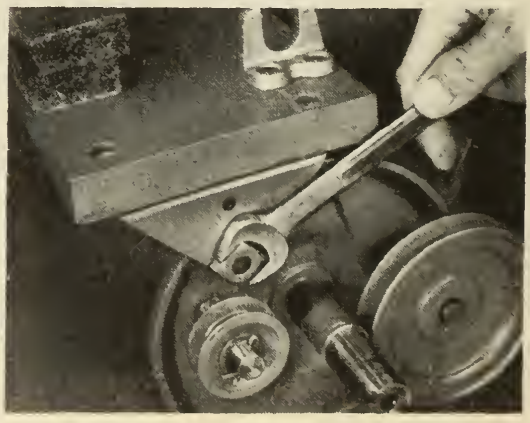
Number of washers needed on blade shaft to keep grass out of bearings is determined by clearance between housing and pulley. Put drop of oil on washers

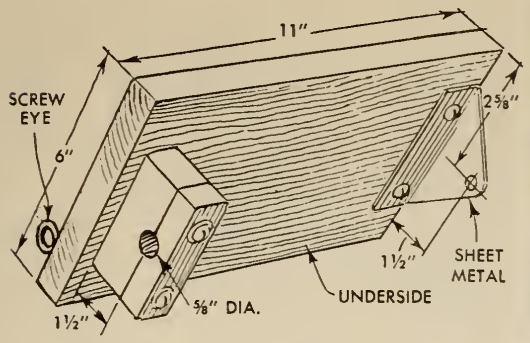


Stub shaft for idler pulley is mounted to wheel housing with machine screw and lock washers. Spacer sleeve on shaft aligns idler pulley with blade pulley



Angle-steel bracket on end of motor platform is bolted to threaded end of protruding mower guard bar. See Fig. 4. Opposite end of platform clamps around bar

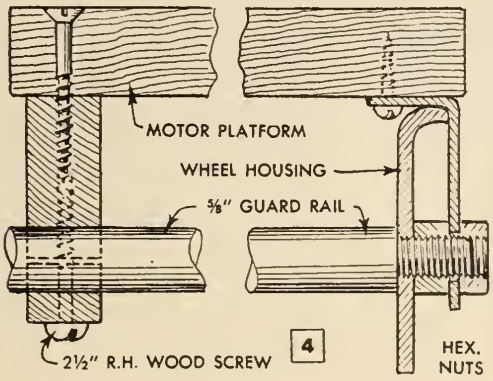




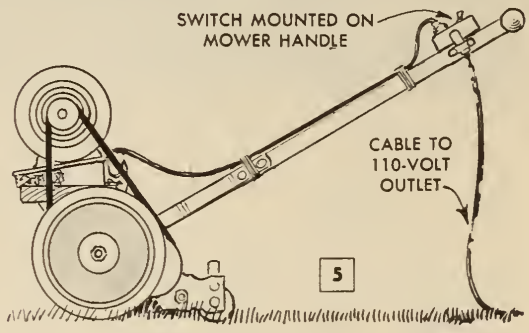
3 MOTOR-PLATFORM DETAIL

shaft is drilled and tapped for a machine screw which is used to anchor the shaft rigidly to the cast-iron wheel housing. A shoulder is formed on the idler shaft with a short length of copper or steel tubing to bring the idler pulley into alignment with the 4-in. pulley. The setscrew is removed from the idler pulley and a cotter key and washer are used to hold it in place on the shaft. Lubricate with a little grease.

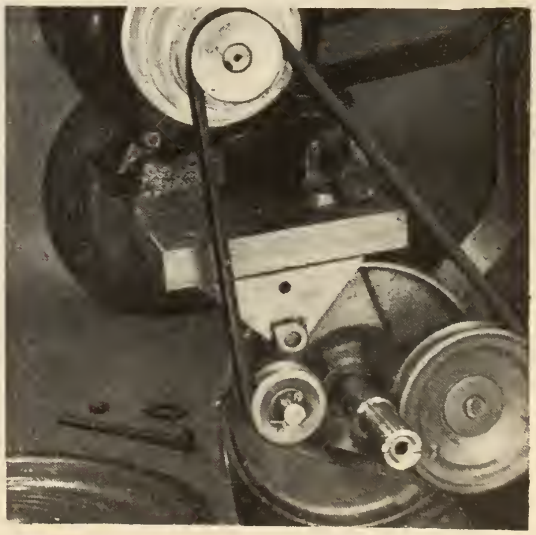
Figs. 3 and 4 detail the motor platform. The motor may be fastened permanently to the platform or held by a floating-type motor rail which permits the motor to be removed easily for use elsewhere. When the latter method is used, a large screw eye is provided to engage the end of the motor-mounting rail and prevent the belt tension from pulling the motor out of the rail clip. A piece of sponge rubber may be used under the motor to take care of belt tension or you can provide a regular adjusting screw in the platform to bear against the base of the motor. Select a standard ½-in. V-belt as close to the required length as possible. Belt play can be taken up by turning the adjusting screw. Adding a sheet-metal pulley guard completes the job. Fig. 5 shows how a utility box fitted with a switch and receptacle can be attached to the mower handle to make it convenient to plug in and control the motor. Although a common



Sheet-metal pulley guard is attached to underside of wheel housing with small machine screws in tapped holes. Where the rim of the housing is not flat, guard can be attached with small angle brackets. Guard keeps tall grass out of the pulleys—can be omitted



interior-type switch box is shown, you should use a weatherproof outdoor-type box to be perfectly safe. Also, the cord from the motor, as well as the 110-v. extension cord, should be heavily insulated and contain three wires so that the third wire can be grounded both to the switch box and to the 110-v. outlet into which the extension cord is plugged. ★ ★ ★

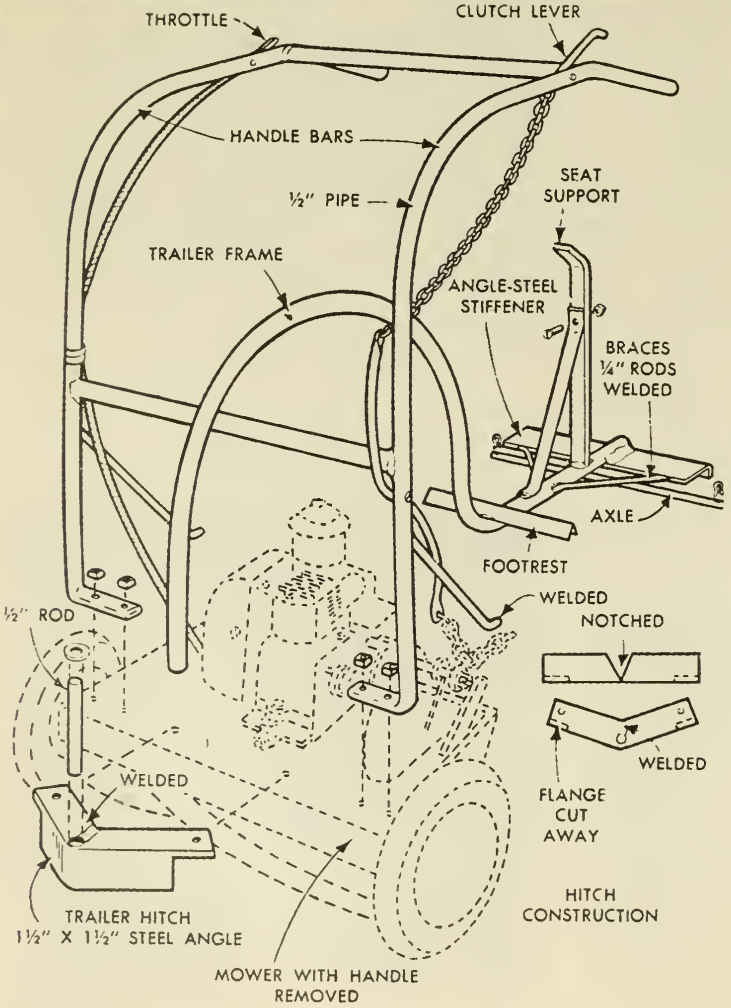


TRACTOR SEAT FOR POWER MOWER

A BIG LAWN looks a lot smaller when you are comfortably seated on this power-mower trailer. Use of a riding trailer such as this one reduces grasscutting time as much as 20 percent since you can make faster, shorter turns and also speed up mowing above a normal walking pace on the straightaway. The trailer unit requires no alteration of the power mower other than removal of the regular handle and substitution of special handle bars and a trailer hitch.

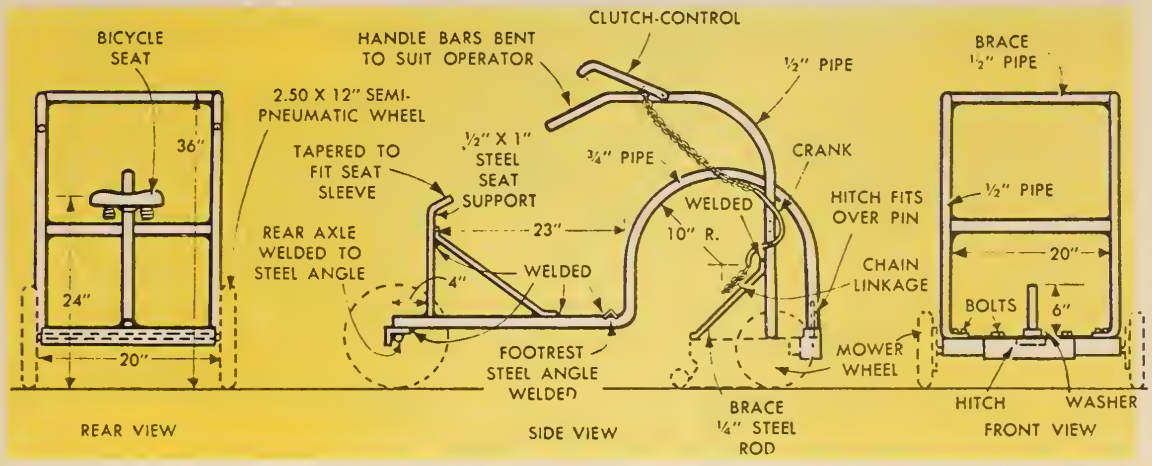
Dimensions given in the detail drawings of the trailer and handle bars on the following page are only approximate. They must be altered to suit different mowers. The detail at the left shows clearly the position of the trailer frame and handle bars in relation to the mower. An improvised extension of the clutch-control mechanism is located on the left handle bar and consists of a chain linkage which works through a bell crank attached to the handle bar below the cross brace. On some mowers the throttle may be utilized but on others an extension may be necessary.

Ordinary black pipe is used for the handle bars and braces. For the curved trailer frame extra-heavy pipe should be used as this unit is subjected to considerable bending stress. If you do not have facilities for making true-radius bends in pipes of the sizes re-



The lawn mower-trailer unit can be made to turn in its own length, an essential feature when mowing around flower beds and in irregularly shaped plots

This photo calls attention to the simplicity of the trailer hitch and manner of assembling the handle bars and controls. The regular mower handle is removed



quired take the parts to your plumber. He can do the job at a nominal cost. Note that the lower ends of the handle bars are bent at right angles and flattened. Holes are drilled in the flattened ends for bolts which pass through holes drilled in the mower shield, or guard. This usually is of heavy sheet metal and will require no reinforcing. Handle-bar braces are welded in place as indicated.

The simple drawbar shown can be adapted to nearly all types of power mowers. It is made by V-notching a short length of steel angle so that it can be bent and the joint welded. Flanges at the ends are cut away to clear the mower guard and holes are drilled for bolts and a ½-in. steel rod, 5 in. long, which is welded to the drawbar angle in the vertical position and serves as a pivot for the front end of the trailer frame. It should be noted that the curve of the frame is stopped at a point about 8 in. from the end. The remainder of the pipe is straight so the parts can swivel freely when it is placed over the pivot pin.

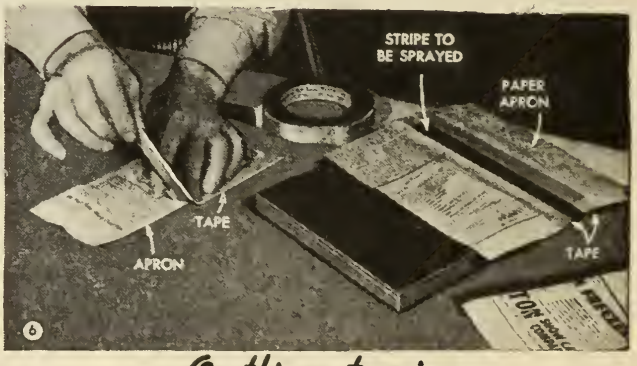
A short length of steel angle welded near the center of the frame just below the bend serves as a footrest. At the rear end the frame is welded to an angle-steel stiffener which in turn is welded to the axle. The seat support is welded to the frame and braced as indicated. A bicycle-type saddle seat is used, and some filing may be necessary to fit it securely over the tapered projection of the support. Angle braces projecting to the rear support the handle bars and the lower ends of the braces are welded or bolted to the mower frame. The trailer wheels are 12 in. in diameter and are of the semi-pneumatic type having integral bearings. They are attached to the axle with cotter keys and washers.

MASKING TAPE

for Striping and Lettering

MASKING tape is a great help to the finisher with an occasional job of lettering or striping. The most popular tape is the crepe-back paper variety, which has enough flexibility for curves. The adhesive usually is rubber-base cement, which holds well, yet strips clean. However, plain paper or cloth tapes can be used.

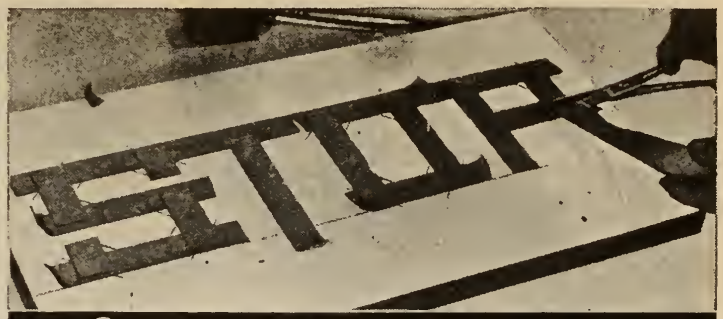
Two methods of taping are commonly employed. In one, the tape is applied to the letter or stripe, the background being sprayed on while the stripe or letter is thus protected. In the second method, the background is sprayed first, then the letter is outlined and sprayed. Direct taping as applied



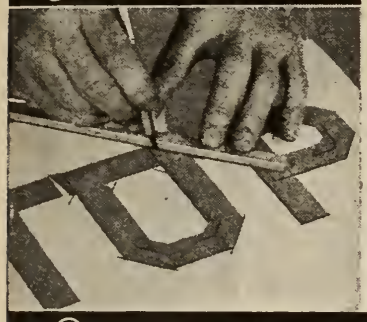
Outline taping

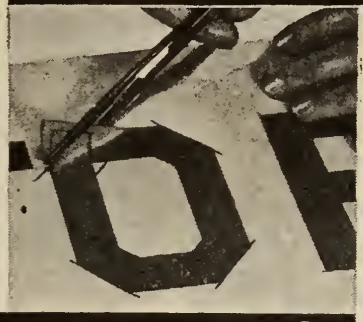
By this method, the work is covered with paper and tape so that only the stripe or lettering is exposed for spraying

⑦ SKETCH OR TRACE LETTERS

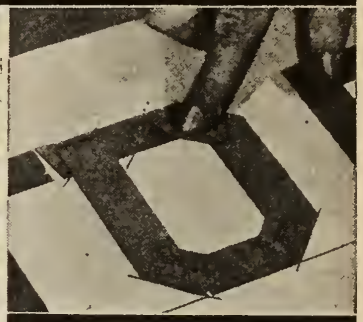


⑧ APPLY TAPE OVER SKETCH, OVERLAPPING ALL CORNERS





⑨ TRIM CORNERS WITH KNIFE OR LIFT TAPE, TRIM WITH SCISSORS ⑩



⑪ USE CUTTINGS TO FILL INSIDE

⑫

Direct lettering

This method used for letters 3 to 10 in. high. Tape gives uniform stems

to a simple stripe is shown in Figs. 2 to 5 inclusive. The area comprising the stripe is sprayed first, using a round spray and allowing the edges to fan out. After this partial coat has dried, the tape is applied and pressed or rolled down firmly. The whole panel then is sprayed, after which stripping of the tape reveals the stripe. The direct method of spraying also is illustrated by Fig. 1. In this instance, the black stripe was first roughed in, followed by the white upper portion sprayed right over the tape, and finished by spraying the lower red portion while protecting the upper white with a cardboard mask.

⑬ TAPE WIDTH TO USE FOR DIRECT LETTERING

Height of Letter	Width of Tape *		
	Thin	Medium	Heavy
3	.515 (½)	.60 (½ or ¾)	.75 (¾)
3½	.59 (½)	.70 (¾)	.87 (⅞)
4	.69 (½ or ¾)	.80 (¾ or ⅞)	1.00 (1)
4½	.76 (¾)	.90 (⅞)	1.12 (1)
5	.86 (⅞)	1.00 (1)	1.25 (1¼)
6	1.03 (1)	1.20 (1¼)	1.50 (1½)
7	1.20 (1¼)	1.40 (1½)	1.75 (1¾)
8	1.37 (1¼)	1.60 (1½)	2.00 (2)
9	1.54 (1½)	1.80 (1¾)	2.25 (2)
10	1.70 (1¾)	2.00 (2)	2.50 (2½)

* Based on stems 1/6, 1/5 and ¼ the height. First figure is exact. Second figure is nearest standard width. All dimensions in inches

⑭ **Block letters**

WIDTHS MARKED IN UNITS 1/6 THE HEIGHT

GATE 2

(15)

Outline lettering

This is especially useful for large letters. Tape is applied to the outlines of a paper pattern to make a combined mask and stencil

⑯ PAPER PATTERN IS FITTED IN PLACE AND LETTERS ARE TRACED

The second method of masking as used for a stripe is pictured in Fig. 6. The whole area of the work must be protected with tape and paper aprons, leaving the stripe area clear for spraying.

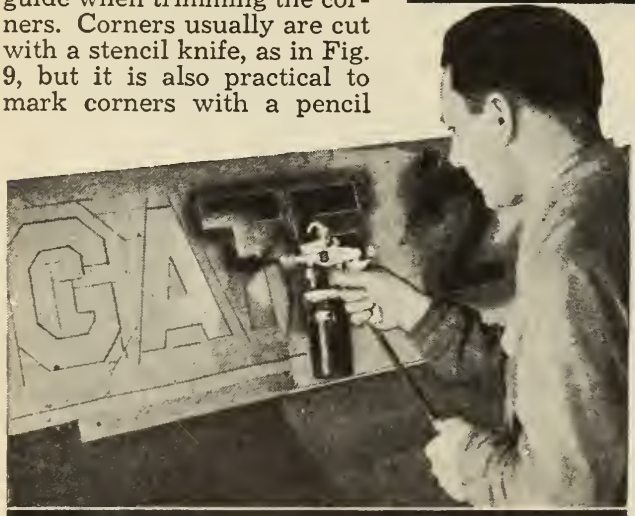
Direct masking of lettering is shown in photos 7 to 12. The inexperienced worker first should draw the lettering on paper, transferring the lines to the work by the familiar method of blackening the back of the paper and then tracing, Fig. 7. However, with very little experience it is quite easy to letter simple block letters, such as shown in Fig. 14, directly on the work. The table, Fig. 13, gives the width of tape to use for thin, medium and heavy stems. The widths of the letters themselves are determined by using a measuring unit one-sixth the height of the lettering. Note when taping, Fig. 8, that all corners are overlapped. This not only stiffens the letter for possible re-use, but also provides a guide when trimming the corners. Corners usually are cut with a stencil knife, as in Fig. 9, but it is also practical to mark corners with a pencil and then lift the tape and cut with a pair of scissors, Fig. 10. In either case, the piece cut off fills the inside of the corner as shown in Fig. 11.

⑰ LETTERS ARE CUT OUT

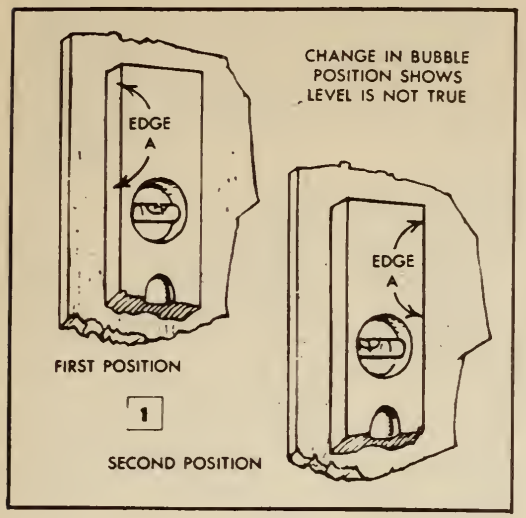
⑱ TAPE APPLIED

Letters over 10 in. high are done best with the outline method. Fig. 15 is an example. In this setup, the background color is finish-sprayed. A paper pattern of the lettering then is made, after which the lettering is transferred to the work as in Fig. 16. The paper pattern in this case serves a double purpose, since it also acts as a stencil. How this is done can be seen in Figs. 17 and 18, the letters being cut outside the line, and the tape applied to the exact outline of the letter and also overlapping the paper pattern, Fig. 18. Spraying is done as in Fig. 19. This combined mask and stencil can be stripped and used several times if needed.

Letters less than 3 in. high are best worked with a stencil cut directly from a wide tape. Wide tapes also are useful for more ornate lettering or designs. This kind of tape can be cut directly over the work.



⑲ SPRAYING IS DONE WITH ROUND SPRAY

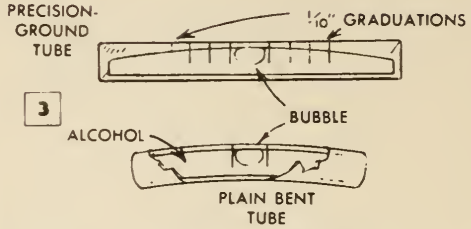


How to USE A LEVEL

By Sam Brown

CORNERS AND WALLS of wood and masonry buildings stand straight and true because the builder used a level to plumb them at the time of construction. He very likely used a carpenter's or builder's level with fixed level tubes in a wooden frame, the simplest and probably the most useful of all the various types of levels. It's made with plain bent tubes, or vials, each containing alcohol, a bubble and two graduations, or witness marks, as in Fig. 3, the lower view. This type of level will show an error of about ⅛ in. in 10 ft., Fig. 4, the lower detail. This is considered permissible in common building construction.

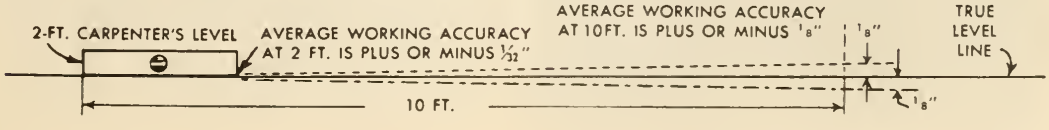
Precision-level tubes are ground inside to a true radius and are graduated to 1/10 in. as in the upper view, Fig. 3. On the precision bench level each graduation can represent, for example, 10 sec. of arc, which is equal to .0006 over a span of 1 ft. Note the table, Fig. 4, which gives comparative values for various types of levels, Fig. 5. Extremely accurate, the precision level must be used correctly as otherwise much

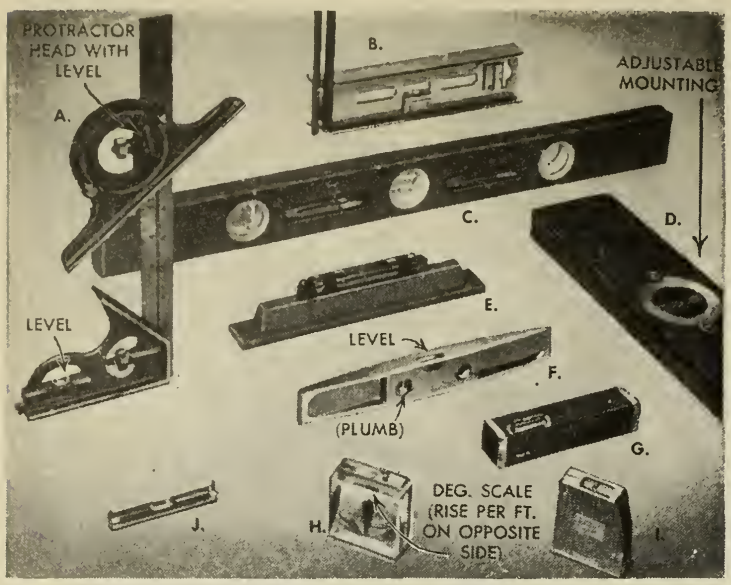


4 LEVEL TUBES

ANGLE PER GRADUATION OR 1/10" BUBBLE MOVEMENT	CHANGE FOR 1/10" BUBBLE MOVEMENT		AVERAGE WORKING ACCURACY	
	At 1 Ft.	At 60 Ft.	At 10 Ft.	At 100 Ft.
2 SEC. OF ARC	.0001"	.007"	.0001"	001"
A 10 SEC.	.0006	.035	.001	.01
A 30 SEC.	.0017	.104	.002	1/64
1 MIN.	.003	.209	.003	1/32
5 MIN.	.017	1.04	1/64	1/10
25 MIN.	.087	5.23	1/16	3/4
B 1 DEG.	.209	12.5	1/8	1 1/4

A–PRECISION BENCH LEVEL B–CARPENTER'S LEVEL





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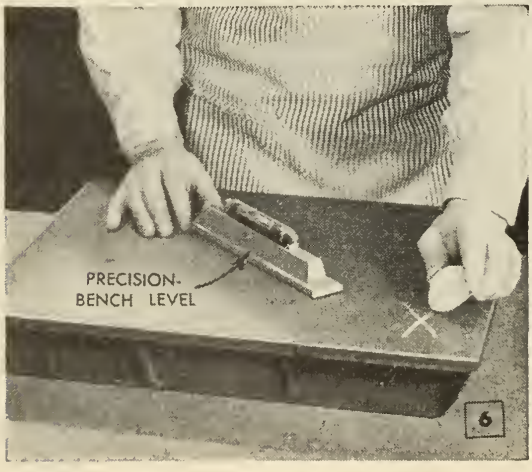
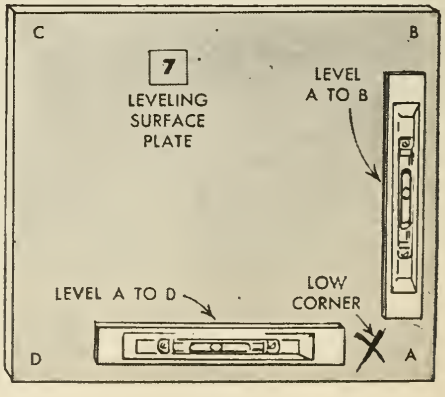
A – COMBINATION SQUARE
B. – LEVEL AND SQUARE
C. – CARPENTER'S LEVEL
D. – ADJUSTABLE LEVEL
E. – PRECISION BENCH LEVEL
F. – 9" POCKET LEVEL
G.-HAND SIGHTING LEVEL
H. – FLOATING PLUMB BOB
I. – TAPE RULE WITH LEVEL
J. – LINE LEVEL

of the accuracy built into it will be lost. As an example, machinists, diemakers and others who use precision levels in the shop always allow at least 30 sec. for the bubble to settle, or stabilize, before taking a reading. Also, care must be taken to see that all contacting surfaces on both the level and the part, or parts, to be checked are perfectly clean. A film of oil, particles of dust or metal chips on any contacting surface will result in an inaccurate reading. Note the variations in average working accuracy of the levels A in the first column of the table, Fig. 4, and compare with B, the carpenter's level. Also note that a 25-min.-level tube has an allowable variation of $\frac{1}{16}$ in. at 10 ft. compared with $\frac{1}{8}$ in. for the carpenter's level. The 25-min. tube is used in some all-metal levels and also in those found on some combination squares.

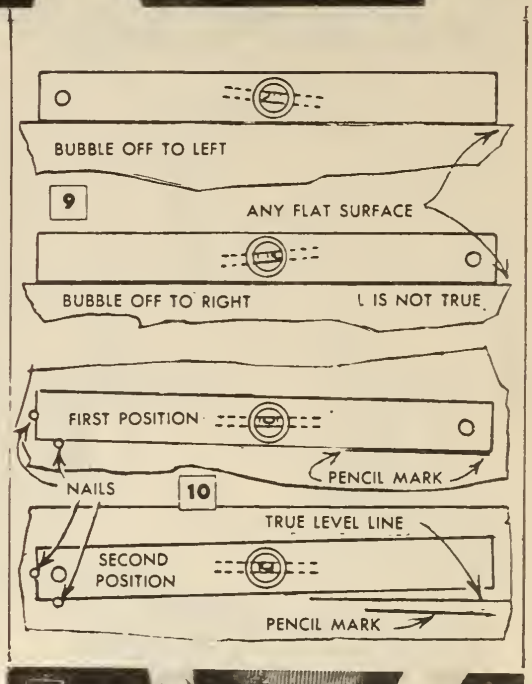
Any level can be tested with reasonable accuracy simply by placing it on a flat surface, noting the exact position of the bubble and then reversing the level and comparing the bubble positions, Fig. 9, also Figs. 11 and 12. Of course, the positions of the bubble and tube have been exaggerated in the drawings for the sake of clarity. A somewhat more accurate test of a level can be carried out as in Figs. 2 and 8. The board used for both the vertical (plumb) and the horizontal test must be flat and smooth. For making the plumb test, Fig. 2, place the board in the bench vise as pictured and drive a small nail near the lower end. Place the end of the level against the nail, center the bubble in the plumb tube and make a light pencil mark on the board along the edge of the level frame. Then reverse the level side-to-side, Fig. 1, center the bubble and make a second pencil mark on the board. Then note the variation, if any, between the two marks. If the variation is not greater than average width of a pencil line then the level usually can be considered sufficiently accurate for prac-

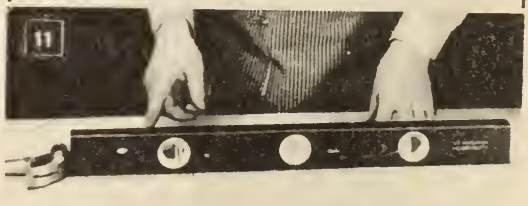


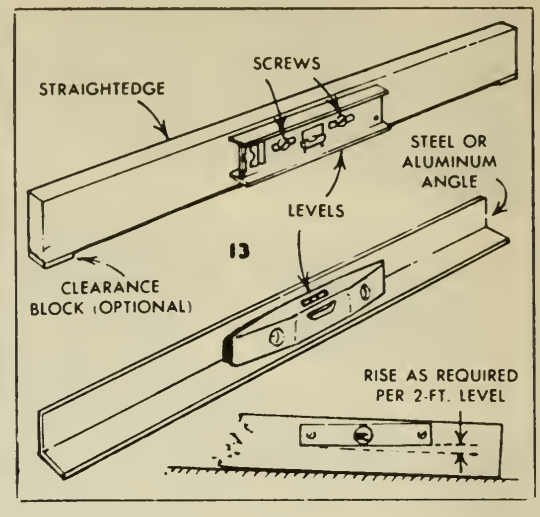


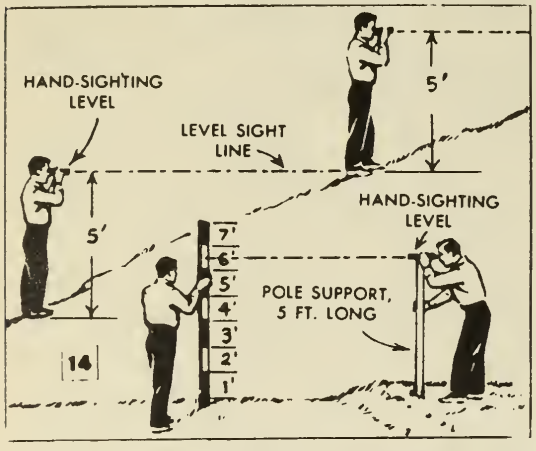
tical purposes. It should not, of course, be depended on for use on work requiring extreme accuracy. Proceed in much the same manner when making the horizontal test, using a board having two nails driven near the end to support one end of the level as in Figs. 8 and 10. When making both tests it's a good idea to repeat each test several times as there may be some slight error in reading the precise location of the bubbles in relation to the witness marks on the tubes. On nonadjustable levels having fixed tubes and wooden frames it may be possible to correct the error, if any, by planing the edges of the frame slightly. Levels having adjustable tube holders, or wells, can be adjusted to compensate for any error that may develop as a result of rough usage.

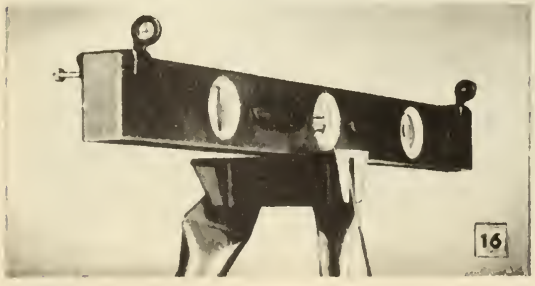
When using a level to check a horizontal surface keep in mind that the bubble moves toward the high side of the work, that is, it moves to the right or left in relation to the witness marks, or graduations, on the tube. When leveling a flat surface, such as a surface plate, Fig. 6, or a bench top or floor, first locate the low corner, A in Fig. 7. Then level the work to the two adjacent corners, B and D in Fig. 7. This is a general procedure for leveling comparatively large, flat surfaces, but when leveling a machine, such as a lathe, it is the usual practice to level first across the width and then check the length. For this work the precision level should always be used. Generally it is best to double check after leveling the machine two ways as the weight of the machine may cause it to settle on the blocking slightly. Also, make sure that the weight of the unit is evenly distributed on all bearing points, or pads, as otherwise inaccuracies may result.





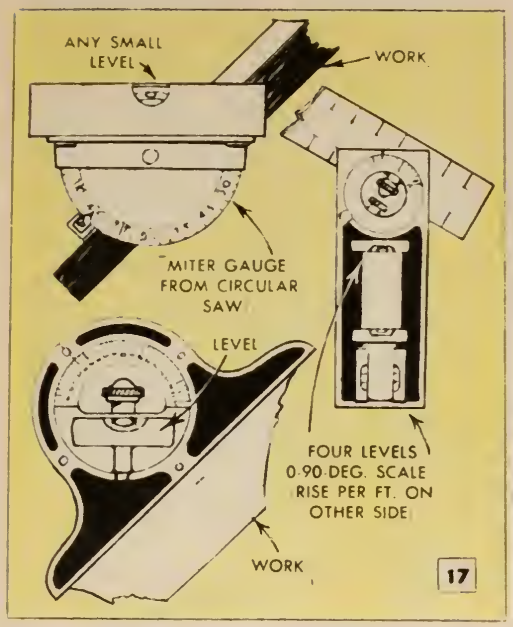






Long level frames do not necessarily add to the accuracy of the level as a unit but they do help to prevent errors resulting from poor contact. This is especially helpful in frame building construction, in laying up masonry and in setting the forms for poured concrete. Rather than use a long level, builders frequently attach a short level to a straightedge as in Fig. 13 and the photo at the left. In this way they gain the accuracy of the long level without sacrificing any of the advantages of the short level for other work. Note that clearance blocks are often nailed to the ends of the straightedge to eliminate any undue errors caused by contact with warped lumber. The level can be permanently attached to the straightedge with screws, Fig. 13, or can be placed on top of the straightedge as in the photo at the left of Fig. 13. Builders often use a level attached to a straightedge to obtain a uniform fall per ft. in a line of draintile. This is done by attaching the level to a straightedge as in the lower detail, Fig. 13.

An ordinary carpenter's level can be fitted with level sights, Fig. 16, and used to project level lines for a considerable distance. When used in this manner the unit usually is attached to a tripod or other rigid support so that it is at a convenient eye level. Another unit, probably more frequently used for this special work, is the hand-sighting level, Fig. 15. In this instrument a mirror reflects the position of the bubble to the observer's eye, making it comparatively easy to run level lines on grades and on level ground as in Fig. 14. For working a slope, or grade, as in the upper detail, Fig. 14, the instrument can be hand-held with an accuracy sufficient for most practical purposes. Where greater accuracy is required, the instrument should be supported on a pole or tripod and sight-



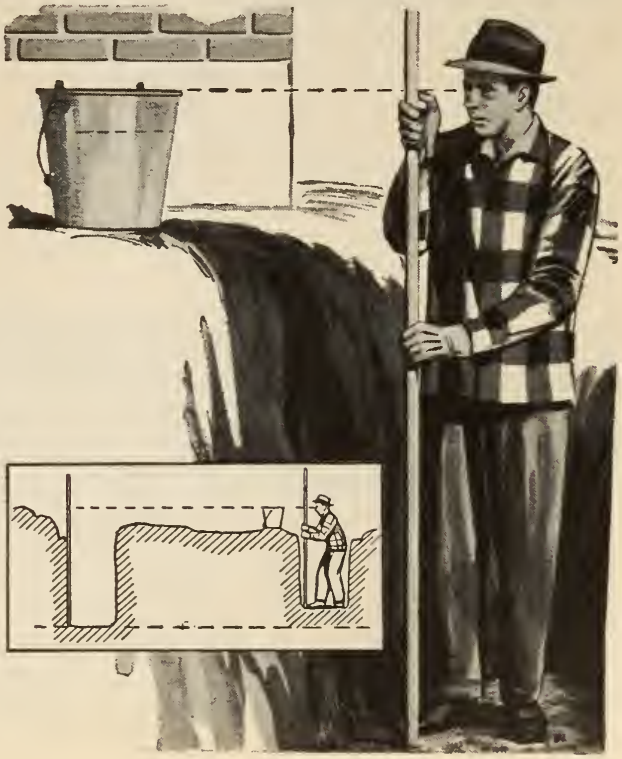
ed on a target as in the lower detail, Fig. 14.

An excellent tool, which employs four level tubes and is especially useful in checking angles in roof framing and other types of more precise work, is shown in the right-hand detail, Fig. 17. One side of the calibrated head is graduated 0 to 90 deg., while the opposite side shows rise per ft. A similar tool is the protractor head, lower left-hand detail in Fig. 17. This usually comes as an accessory to the combination square, but for determining angles it is used without the blade, or scale. The built-in level provides a means of checking angles accurately, an example of its many unusual applications being shown in Fig. 18. Lacking these precise units, accurate angular checks can be made with the miter gauge from the circular saw used in combination with a small level, upper left-hand detail in Fig. 17. Very accurate work can be laid out with this simple setup. ★ ★ ★

Improvised Surveying Level Requires Only Pail of Water

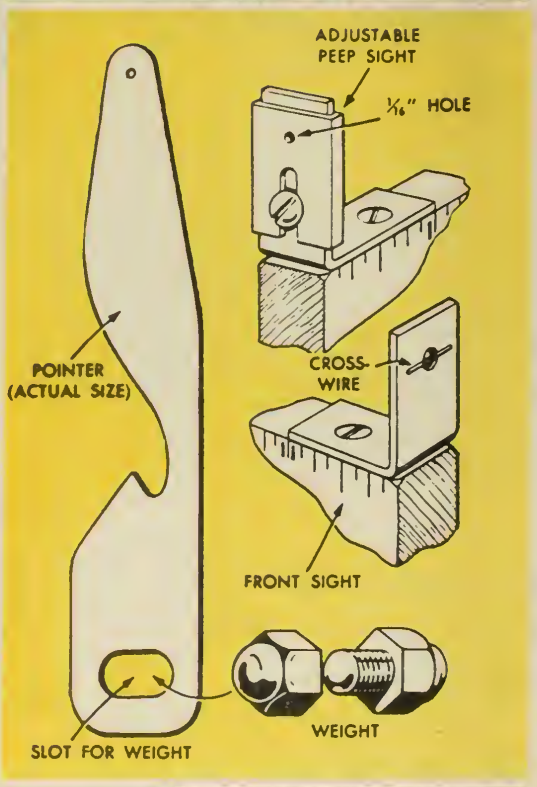
When you need a surveying level for such jobs as grading your yard, or for laying draintile, you can improvise one from a pail of water that will be accurate enough for all practical purposes. Place the pail on high ground and adjust it until the water is the same distance from the rim at three equidistant points around the rim. Sight from a pole, such as a clothesline prop, across the leveled rim of the pail to another pole as indicated. A friend can mark the other pole at the point where you sight, and the relative heights at the lower ends of the poles can then be determined by measuring down from the marks.

R. G. Cooper, Trenton, Ont., Can.



MEASURING HEIGHTS WITH A LEVEL

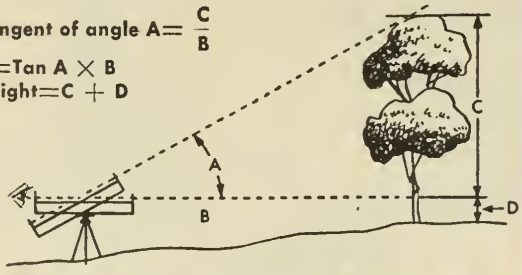
HERE'S A TOOL which not only aids in laying out a driveway or leveling a plot of sloping ground but also can be used to measure the height of a tree or structure too difficult to measure by other means. It consists of a 12-in. spirit level, two angle-brace sights, a protractor and a weighted pointer. Assembled as shown in the photo at the right, the unit may be fastened to a camera tripod. Precision sights may be purchased for mounting on the level, but relatively accurate sights can be made from two 1-in. angle brackets as shown below and at the right. The protractor is fastened to the side of the level with its center point 2⅜ in. from the front end and ½ in. down from the top. Cut the pointer from thin metal to the pattern given in the detail. An adjustable balance weight for the pointer is made from a bolt and two cap nuts. Suspend the pointer from a nail driven into the level at the center point of the protractor. For tripod mounting, recess a mending strip in the bottom edge of the level, centering it 5 in. from the sighting end. Drill and tap a hole through the strip to accommodate the mounting screw of the tripod. To measure the height of an object a known distance away follow the formula given below:

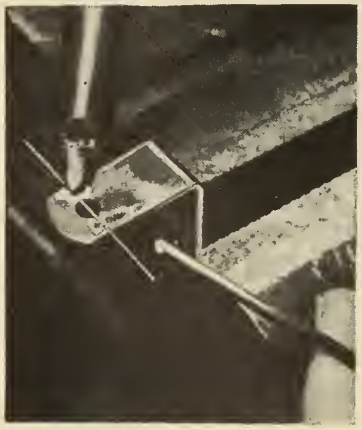


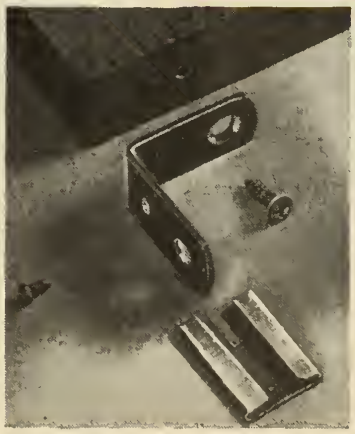
Tangent of angle A = $\frac{C}{B}$

C = Tan A × B

Height = C + D







Wooden Triangle Replaces Level For Vertical Course of Bricks

For the amateur mason, laying a vertical or "soldier" course of bricks is difficult, especially where a level cannot be used conveniently. To overcome this problem, one homeowner uses a triangular "square." The square is a right-angle triangle cut from 2-in. stock, having legs 12 in. long. When one leg is placed on the level course below the soldier course, the other leg positions the bricks vertically.

Lightweight Level Improvised For Jobs Around the House

Improvised from a yardstick and a small level, a lightweight but long level can be used for dozens of jobs around the house. Easily held with one hand, the level can be used to align large pictures, scribe level lines for installing wall tile and similar jobs. Make sure the yardstick to be used is straight by holding it edgewise on a table or other flat surface. When attaching the level to the yardstick, place both on a flat surface and align their bottom edges.

Stairway Lift Aids Handicapped

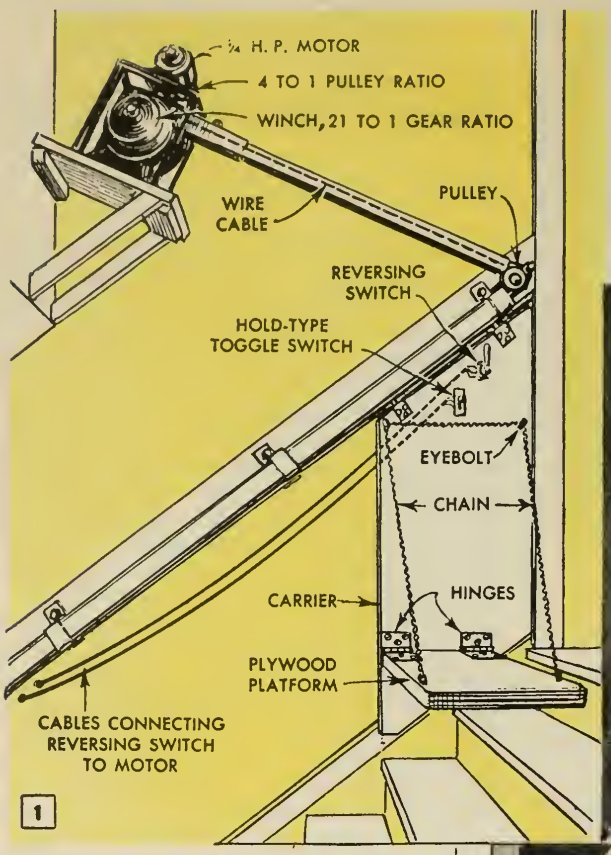
By C. L. Veitch

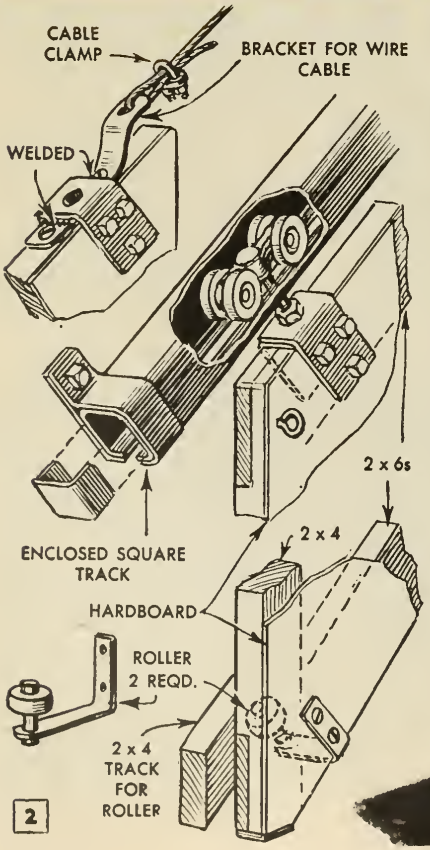
IF A MEMBER of your family becomes permanently disabled, making it extremely difficult or impossible for him to climb the stairway unaided to a second floor, here is a track-mounted lift that can be operated at his convenience. The lift consists of a carrier unit that is mounted on enclosed track of the type used for sliding garage doors. The track is lag-bolted to wall studs at the proper height above the steps. Power for operating the lift is provided by a winch and reduction gears driven by a ¼-hp. motor that is controlled from switches located on the carrier.

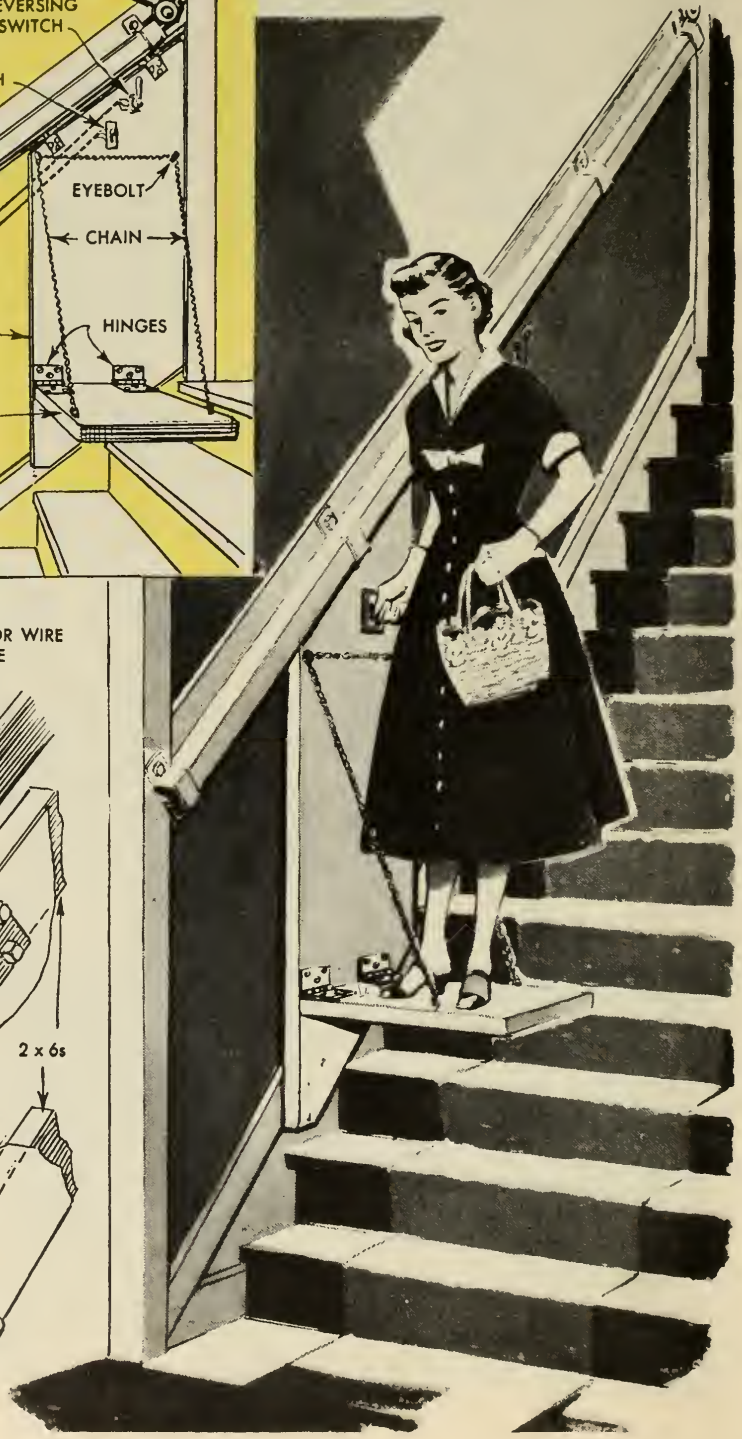
In operation, the rider boards the carrier and rotates the reversing switch to select the direction of travel desired. Then the toggle switch is held down to turn on the power. A steel cable clamped to the carrier and anchored on the winch drum is then wound on the drum, or payed out, depending upon the direction the carrier is to travel. A stop switch installed at the upper end of the track automatically stops the carrier when the landing level is reached. To stop the carrier at any point along the stairway, the rider-operator need only release the toggle switch to cut the power.

To build a stairway lift such as the one illustrated, measure the stairway from lower to upper landing to determine the length of track required. When mounting the track on the wall, it is important that all brackets be located to permit driving the lag bolts into wall studs for proper support of the assembly. The carrier is made of hardboard cut to the shape of a parallelogram and screwed to a frame of 2 x 4s and 2 x 6s as in Fig. 2. The top and bottom of the latter is angled to match the incline of the stairway. The platform is held in a horizontal position by means of hinges and chain to permit folding it against the carrier when not in use. Electrical cables connecting the toggle and reversing switches with the winch motor are concealed in the wall as indicated. By inserting the cables in holes drilled midway on the wall, the exposed cable need be only half the length of the track, Fig. 1. The winch used on the model shown, is a hand operated war-surplus portable bomb hoist converted to power drive and mounted on a shelf, out of view from below.

Don't let a heart condition or other ailment force the sale of your two-story home. Build this electrically powered lift instead to avoid climbing stairs







Good Indoor Lighting for Your Home

Adequate home lighting falls into two groups, which must be combined for best results. These are over-all room illumination and lighting for specific tasks.

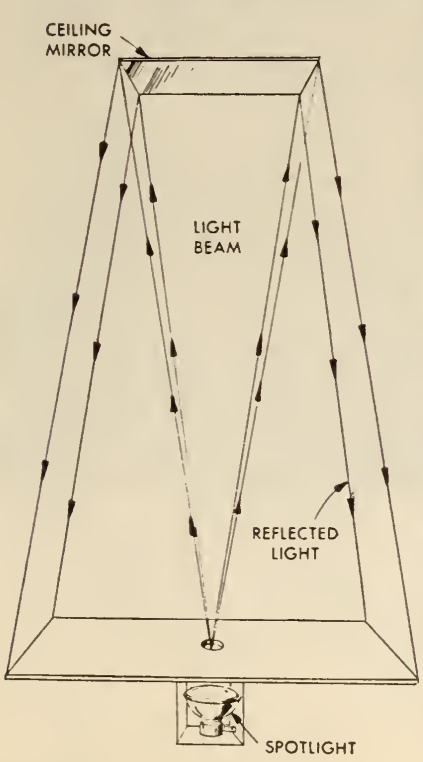
An indirect-lighting arrangement with a spotlight under the table to reflect from an overhead mirror and add sparkle to the formal dinner; without the tiring glare of direct lighting, or the shadowy uncertainty of candles, is one example of lighting for a specific purpose.

In this arrangement, a spotlight is trained on a mirror attached to the ceiling. The light beam passes through a 2⅝ in. hole bored in a table leaf. The size of the mirror, which is centered over the table, should be one half that of the table top. Use a projector-type spot lamp of 100 to 150 watts and mount it below the table top in a porcelain socket attached to a bracket. Enclose the light in a metal housing provided with louvers for ventilation and flanges for fastening. The table leaf is protected with asbestos and a glass centerpiece can be used to conceal the lamp.

There are many other recommended lighting recipes for various specific purposes, however, space does not permit giving all the information on lighting recipes.

As built-in cove lighting along the walls of a room is quite costly in most cases, the valance has become a popular and effective substitute for obtaining diffused over-all illumination. The detailed draw-

A spotlight trained on a ceiling mirror will provide over-all room illumination.



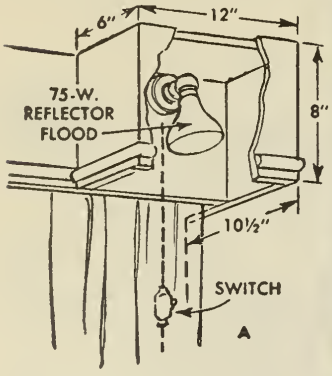
Ordinary overhead lighting (left) is not as effective as the spotlight method (right).

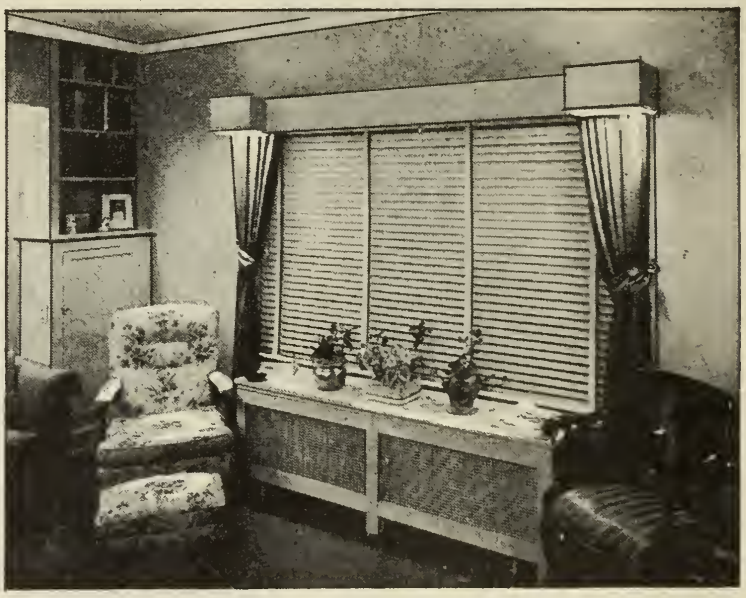
ing gives the basic dimensions for different types of window valances—one type for direct lighting only, another for indirect only and a third type which supplies both direct and indirect light.

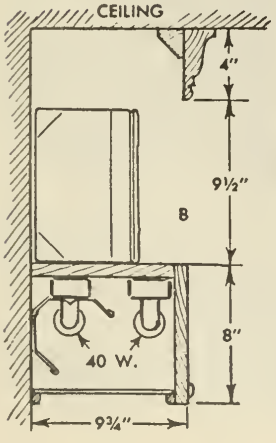
The valance intended for indirect or combination lighting should be mounted 12 in. or more down from the ceiling; and the lamp channel is located flush with the top edge of the valance. These two factors are important in order to attain maximum spread of light.

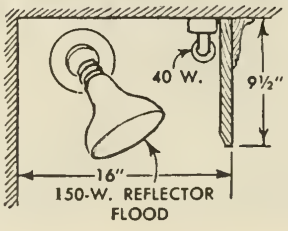
The 4-in. distance from the wall or woodwork surface to the center of the

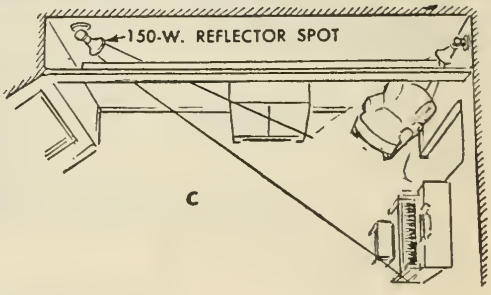
Individual valance lighting can also fill a room with illumination.

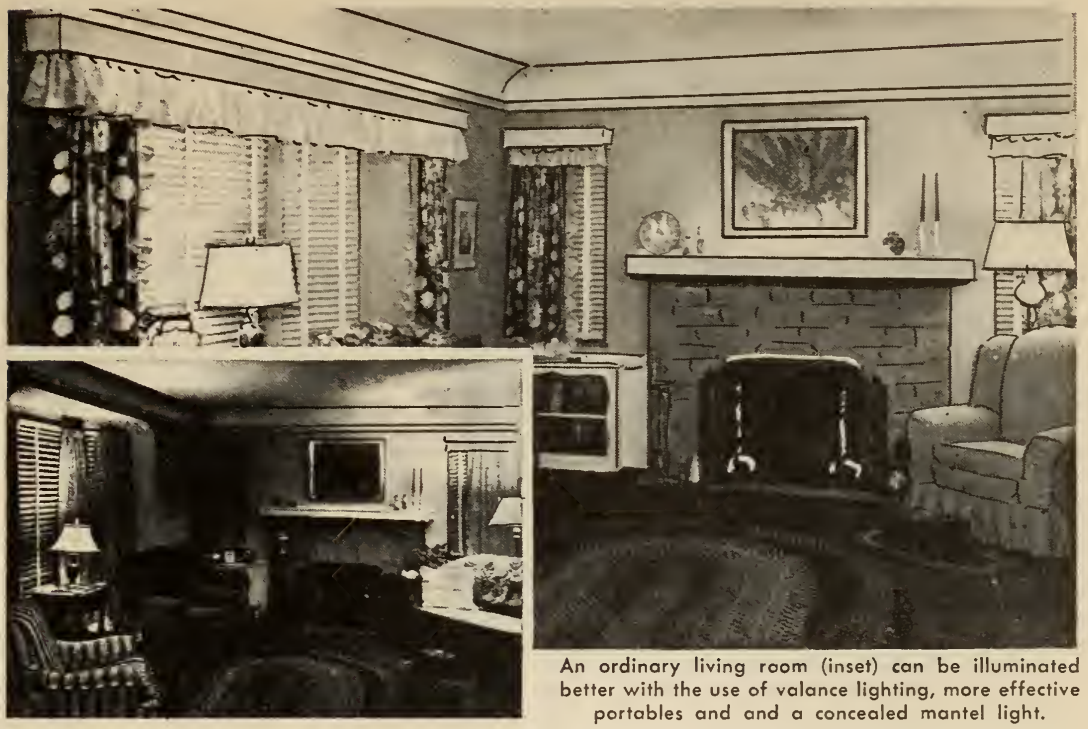










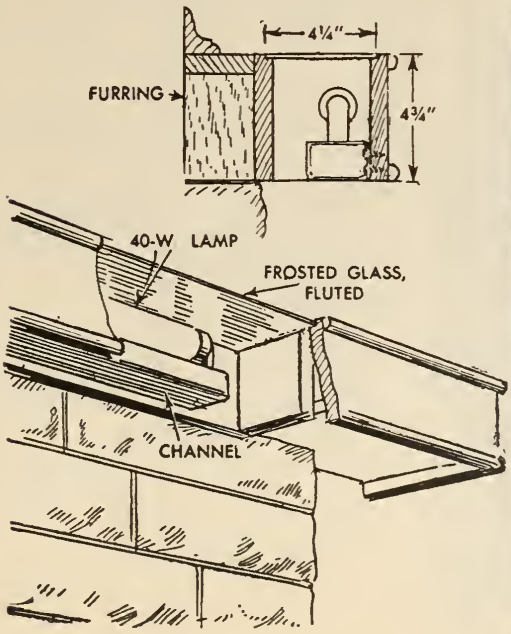


An ordinary living room (inset) can be illuminated better with the use of valance lighting, more effective portables and and a concealed mantel light.

lamp is also important in order to have distribution of light over the full length of drapery, which should be hung as close to the wall as possible.

However, if it is discovered that with present traverse rods, the 4 in. dimension does not bring the fluorescent tube beyond the drapery, increase the thickness of the wooden backing strip to bring the channel farther out from the wall. Then increase the distance from the valance to the wall proportionately.

A concealed mantel light is easily constructed by following this detailed drawing.



A panel of white painted fiber board above a student's desk will provide a reflecting surface to attain maximum light from pin-up lamps.

Paint all inside surfaces of the valance white to reflect the maximum amount of light.

The length and location of valances as well as the type selected is determined by the arrangement of the room and the effect desired.

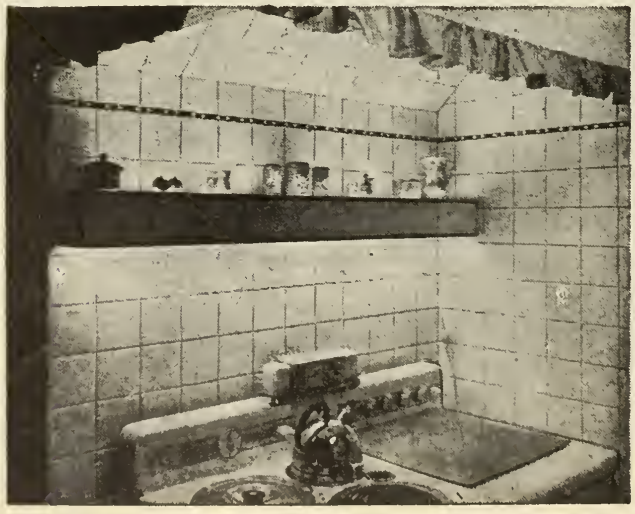
In one instance a valance may be used to provide lighting along the entire length of a single wall to balance the light from portable lamps. In another, full-length valances may be installed along opposite or adjoining walls, or it's possible that window-length valances can be used over the windows all around the room so each wall contributes to the over-all lighting effect.

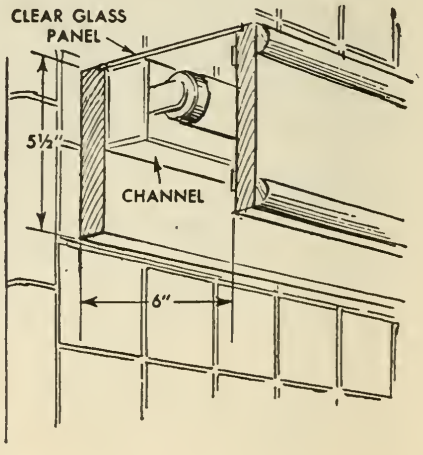
Bays, alcoves, picture windows, offsets and wall sections or windows flanking a fireplace all lend themselves extremely well to the valance-lighting treatment.

The installation of valance lighting will permit moving the furniture to new arrangements previously impractical because of insufficient light.

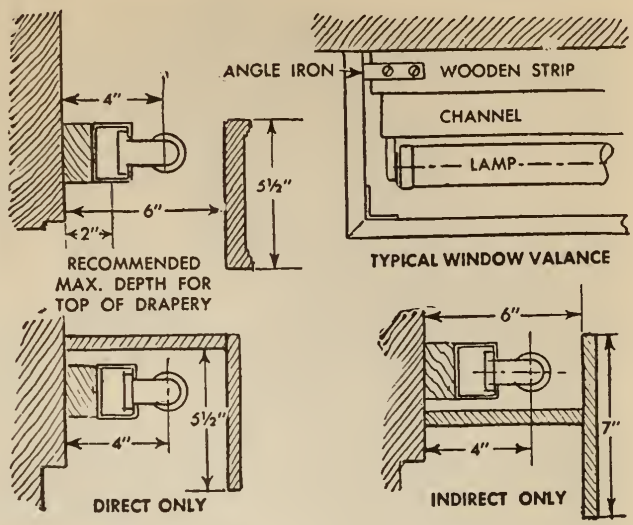
A few of many possible lighting installations are pictured and detailed in this section.

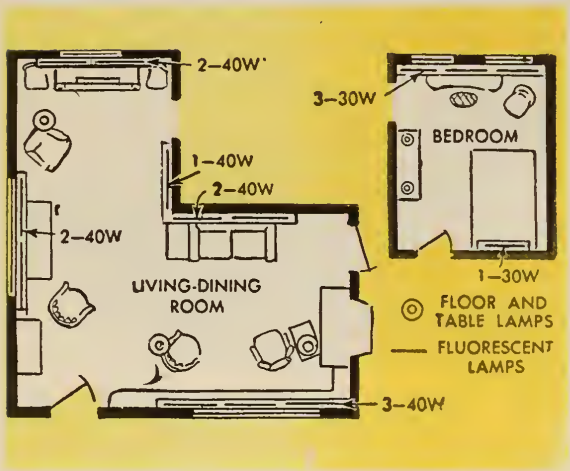
This wall bracket not only provides light for kitchen work, but it doubles as a handy and attractive spice shelf.





These are the basic dimensions for three different types of lighting fram window valances. They include the direct lighting type, the indirect lighting type, and a combination of the two.





This is an example of how furniture and portable lamps can be arranged when the general lighting level of a room has been increased by the use of valance lights.

A lighted bookcase with a glass top plus a ceiling spotlight trained on a painting form a bright and dramatic corner of a living room in an apartment or small house.

"LINOLEUMIZE" Your Kitchen and Bathroom

AVAILABLE in a variety of colors, patterns and weights, linoleum is being used by many homemakers as a covering material for almost every surface in the home that receives hard use or is exposed to frequent soiling. Remnants that usually are obtainable at low cost from linoleum stores, are large enough for steps on hall and basement stairways, window cornices, doors and other small surfaces. The photos on this page and the next illustrate only a few of many such uses for linoleum. The next time you redecorate the bathroom or kitchen, consider using linoleum to cover all or part of the walls and other minor surfaces. Easy to work with adhesives and ready-made metal moldings that come in a wide selection of styles permit anyone to turn out professional-appearing work.★★★

Fig. 1: For long service and easy cleaning, wax your linoleum only with preparation made especially for it. Fig. 2: Tile-patterned linoleum dado provides attractive, easily cleaned wall covering for lavatory

Fig. 3: Scarred and badly worn kitchen cabinets are given "face lifting" by covering of linoleum in solid color that contrasts with countertop and floor. Linoleum is cut to fit each door and drawer front and cemented in place

Fig. 4: Odd piece of linoleum is used for covering top of sewing table to provide smooth, easy-to-keep-clean surface that does not snag lightweight synthetic materials. Such pieces can be purchased as remnants at very low cost

Fig. 5: Inlaid linoleum leftover strips are excellent for covering hall or basement steps to save them from the hard wear resulting from sand and other highly abrasive particles frequently tracked in from outdoors and workshop

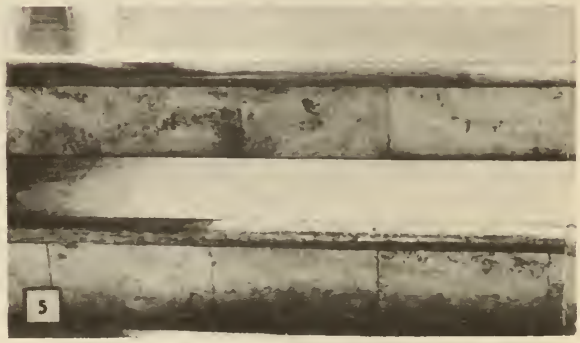


Fig. 6: Attractive patterns and colors available in linoleum make it an excellent covering material for cornice to give interesting treatment to kitchen window. The smooth surface can be kept clean with very little effort

Fig. 7: Painted kitchen door was hard to keep clean until it was covered with linoleum in color that blends with doorway and upper half of walls. Edges of linoleum at side and bottom of door are beveled to prevent tearing it

Fig. 8: Desk top is covered with remnant piece of linoleum in solid, dark color. Edges of linoleum are beveled on all sides for attractive and serviceable writing surface. Ink stains and soil are easily removed with a damp cloth

WORK SAVING

By A. M. Wettach

TO MAKE livestock feeding easier and quicker, here are several handy feeders that can be made on the farm using common materials and tools. Bunks that are used for dispensing feed in large quantity are attached to the building in which the feed is stored or prepared for use, while other feeders are mounted on skids or runners for convenient moving to pasture or feedlot. A few of the feeders are provided with some type of shelter, such as the novel but useful salt rack shown on the opposite page. A vane bolted to the top of it enables the revolving feeder to point into the wind so that rain and dust do not blow into the opening on one side.

Upper left, no supporting legs are in way of cattle feeding at this bunk which is attached to inside wall of cattle shed. Front and bottom of bunk are made of 2 x 10 planks nailed to heavy wooden braces that are nailed to sill and upright-framing timbers

Center left, stanchion-style feed bunk in cattle shed keeps feed waste to minimum by preventing cattle from dragging hay out of bunk and trampling it. Baled hay is dropped through mow-floor openings directly overhead for convenient scattering in bunk

Below left, minerals and salt are kept dry, yet accessible to cattle at all times, in sheltered feeder made of rough-sawed pine lumber cut to size and bolted together throughout for sturdiness. The 4-ft.-sq. box has separate compartments for minerals, salt

Below, heavy-duty feed bunk for cattle is made from large boiler cut in half. Sturdy legs cut from 2-in. steel pipe and welded to tank sides at each end provide support for bunk at desired height. Bunk is ideal for grain, ground feed, silage or water

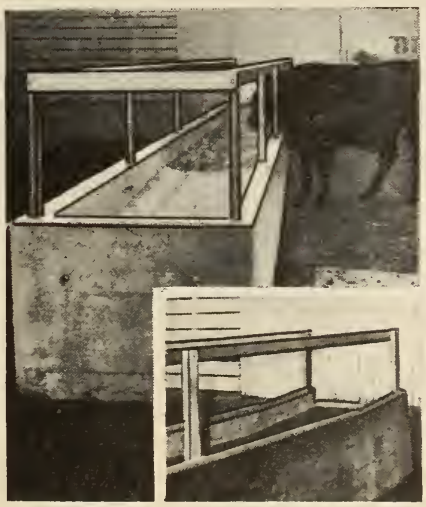
LIVESTOCK FEEDERS

Above, rims from two discarded manure-spreader wheels cut in half and bolted to underside of feed bunk, provide sturdy legs and serve as runners for easy moving to new location. Lengths of steel angles welded to rims, prevent them from spreading

Right, vane on revolving salt rack for sheep permits rack to head into wind to protect salt from rain. Metal basket is nailed to platform on which pipe flange and length of pipe are screwed. Latter turns in larger pipe and flange assembly bolted to wheel

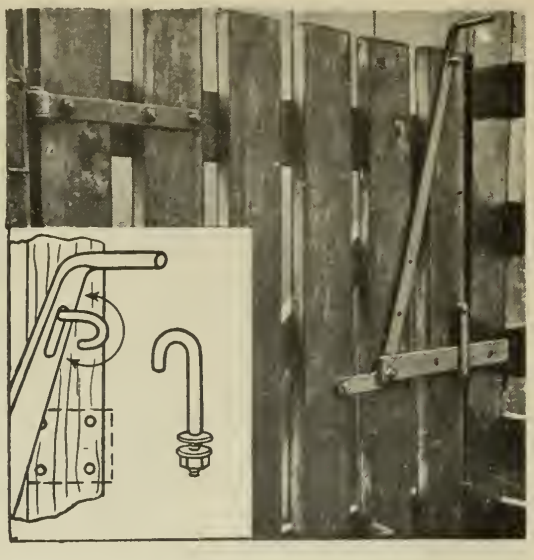
Below left, poured-concrete bunk for feeding ground feed and grain to cattle is attached to granary to save work. Sliding door permits direct access to bunk from granary. Framework at top consists of a channel-steel rail that is bolted to steel posts

Below right, 9 x 16-ft. self-feeder for livestock holds 100 bales of chopped hay and has 2-ft. side manger on each side. Uprights are 4 x 4s to which 2-in. planks are bolted to height of 18 in. for sturdy base. Note substantial overhangs on roof



Single Tank Waters Livestock In Four Separate Lots

A large water tank, placed at the intersection of two fences, will accommodate livestock in four separate lots. Note the positions of the four fence posts. These hold the tank securely and, at the same time, provide support for the wires which continue across the top of the tank.

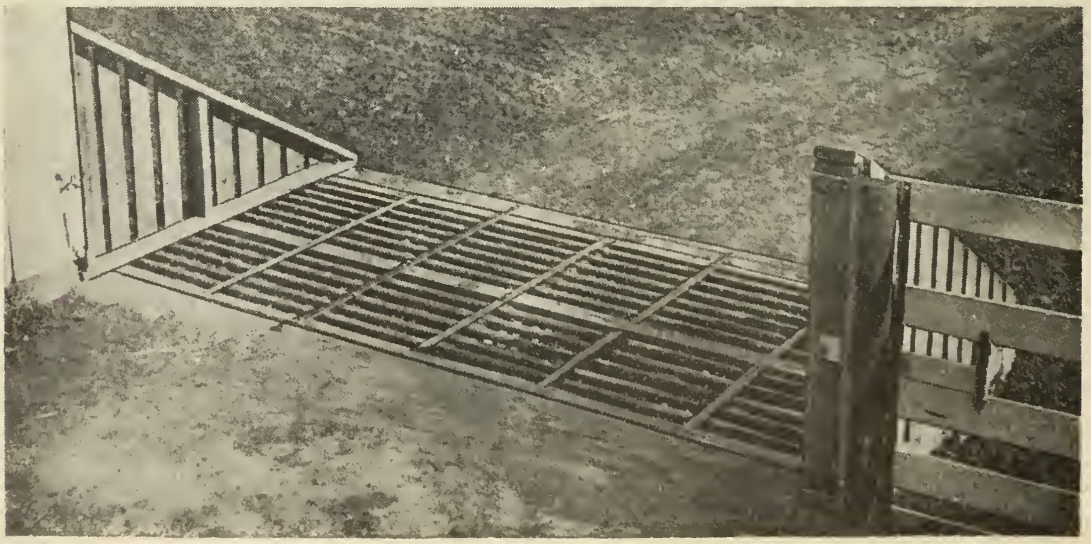


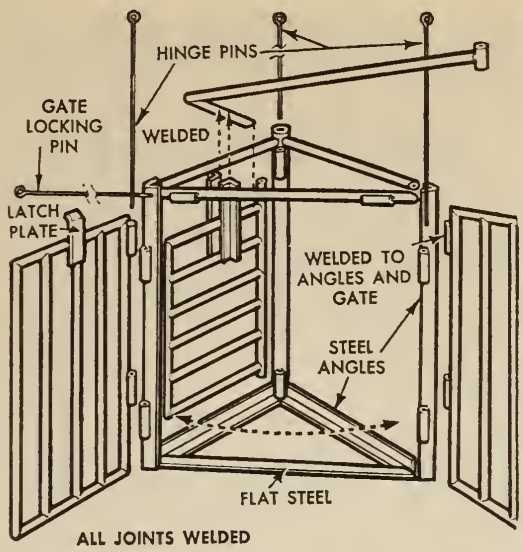
Locking Bolt for Stock Gate

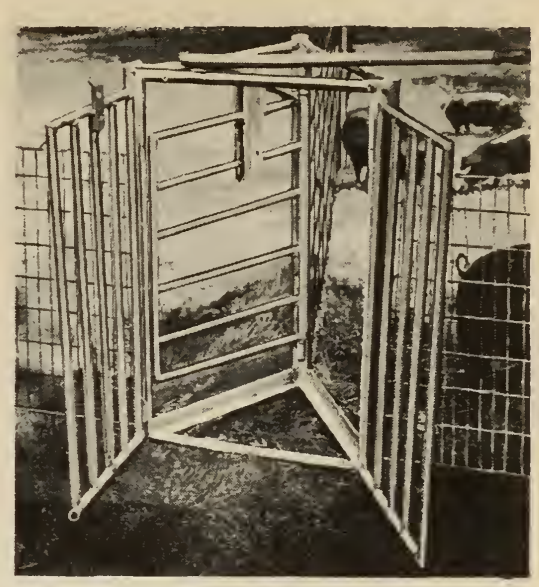
Stock cannot open this latch, which makes it ideal for use on gates between feed lots. A lever attached to the bolt has a slot at the upper end that engages a hook bolt when in the closed position. The locking feature is provided by the bolt which prevents release of the lever when the hooked part is turned at right angles to the slot as in the detail above.

Wings Prevent Livestock From Stepping Over Ends of Guard

Wings on the ends of this cattle guard prevent livestock from passing through the gateway by jumping over the corners of the guard next to the fence. The wings, which are 4½ ft. high, also prevent livestock from being crowded onto the guard from the ends. A gate to one side of the guard allows stock to be moved both in and out. The guard is 7 x 12-ft., is made of 2-in. pipes spaced 5 in. on centers and rests on a shallow concrete pit. The pipes are kept in place by lengths of flat steel welded to them at right angles as shown in the photo.—A. M. Wettach, Mt. Pleasant, Iowa.







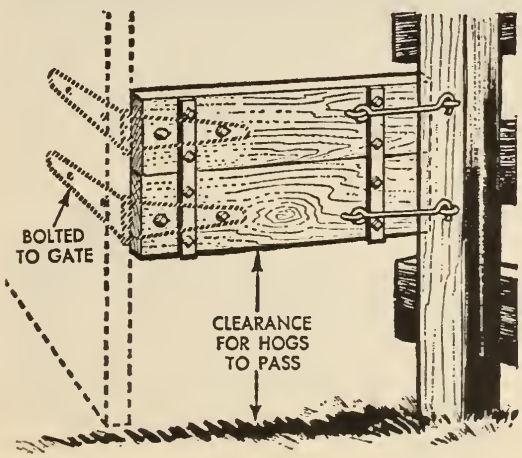
Above, welded-steel gate is located at corners of three adjoining feed lots, permitting farmer to turn hogs into any lot desired by opening or closing the wing gates and then positioning the diverting gate accordingly

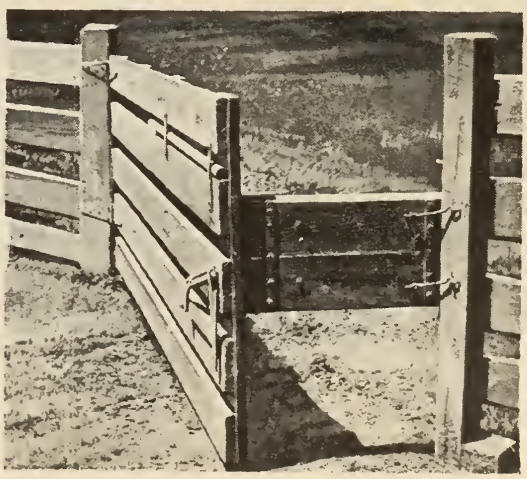
Gates That Make It Easier to Handle Hogs

Here are two combination gates that will interest hog raisers. The sorting gate shown in the photo and drawing above consists of a two-way gate and two wing gates, each of which is mounted on one corner of a pipe and steel-angle frame of triangular shape. When installed at the corners of adjoining feed lots, it enables one man to sort and shunt pigs being driven from one lot to either adjoining one, simply by opening or closing the wing gates in front and positioning the gate at the back accordingly. The wing gates also make the device handy for loading hogs directly from the feed lot. These are made of lengths of pipe cut, fitted and welded together as indicated in the drawings. Short lengths of pipe welded to the gates and frame form hinges when fitted with pins cut from steel rod.

The sturdy gate extension shown in the photo and drawing below forms a creep, permitting hogs to pass but preventing cattle from doing so. Mounted on hinges bolted at the end of an existing gate, it is hooked to the gate post by double hooks when in use as in the photo. When the main gate is to be closed, the extension first is swung back on it and hooked in place. The only materials needed to make the gate extension are two 1⅝ x 7½ x 24-in. planks, two strap hinges, two short lengths of ¼ x 1-in. flat steel and a pair of heavy hooks.

Hinged extension mounted midway on end of gate allows hogs to pass from barn to feed lot but not cattle





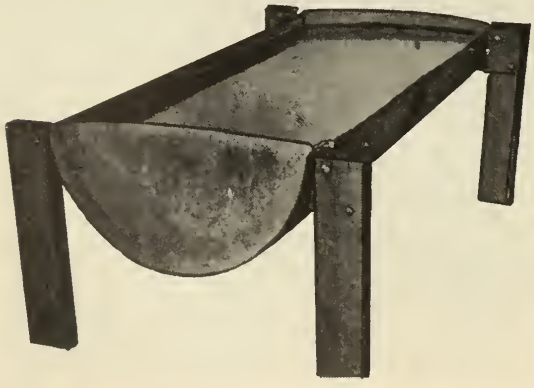
Dairy Feeding Cart Made From Old Fuel-Oil Tank

Cutting a large oil tank in half lengthwise and dividing it into compartments provided an ideal feeding cart for one dairyman. The partitions were welded in place, after which wheels were added, two in front and a pivoted one at the rear. These can be of any convenient size, preferably wheels fitted with rubber tires.

Charles L. Stratton, Windham, N. H.

Watering Trough for Cattle

One farmer made this sturdy watering trough for his cattle by cutting a large steel oil drum in half lengthwise with a cutting torch. After the rough edges were ground smooth, a piece of steel plate was welded at each of the four corners to provide a means of bolting on the wooden legs as shown. The legs can be made from lengths of 2 x 6-in. oak as shown, or steel angles or flats.



LIVESTOCK SUNSHADES

By A. M. Wettach

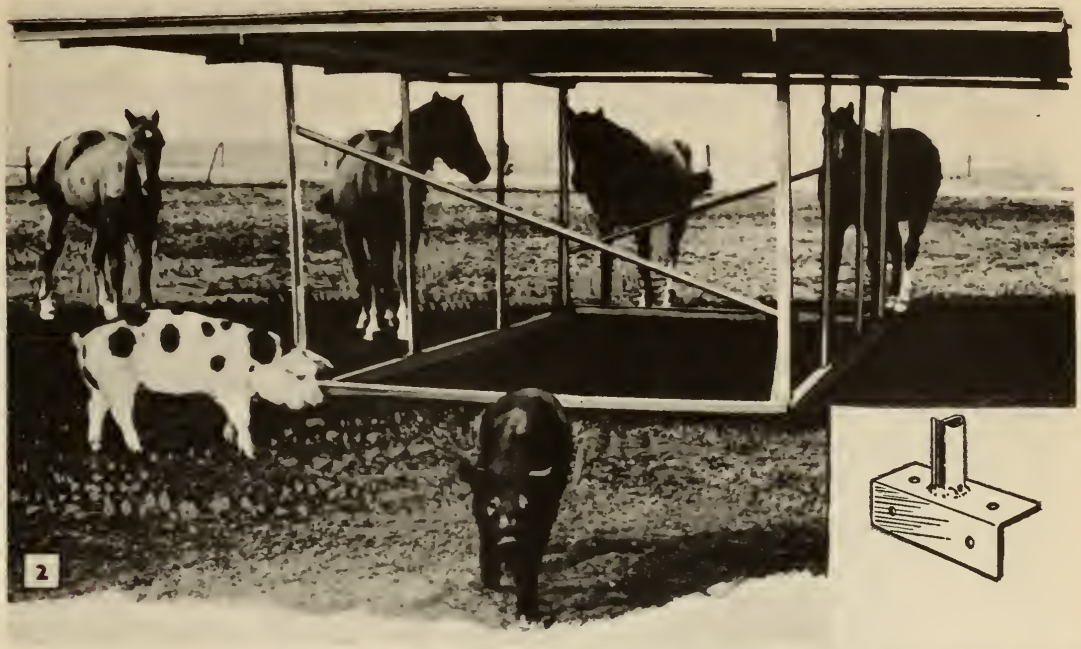
1 Low sides and an arched roof help to prevent this shelter from being overturned by wind. The roof arch is formed by edge-nailing a 2 x 4 midway on the rafters on each side of the roof, then attaching corrugated roofing to span the roof arch

2 Livestock of all sizes can be accommodated by this sunshade, the frame of which is made of angles and pipe lengths welded together and fastened to wooden runners as indicated. Shiplap boards nailed to roof stringers provide the shade

3 Here is a low sunshade for hogs that is mounted on farm-machinery wheels for easy moving. The "roof" of this unit consists of a frame of 2 x 4s to which lengths of woven-wire fencing are nailed and then covered with a 6-in. layer of hay

4 This sunshade for hogs is similar to the one shown in Fig. 3, except that the frame that takes the thatch of hay is raised above the wheels to provide clearance for large hogs. Hay is ideal because it acts as a heat barrier as well

5 Lengths of steel pipe welded together as shown form the frame of this portable sunshade for hogs. Woven-wire fencing stretched across the top and tied in place with wire prevents the loose thatch of hay from falling through the mesh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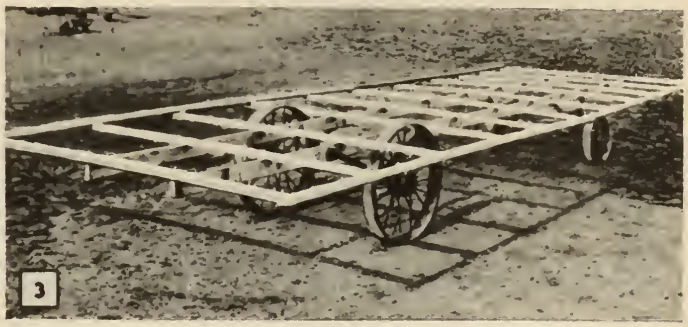

3

4

5

Water "Piped" From Well to Pasture

While temporarily pasturing a cornstalk field where water was unavailable for the cattle, one farmer "piped" water in from a well in a pasture across the road, as shown in the illustration. From the well the water was carried by means of a pipe laid across the ground. To solve the problem of crossing the road with the water line, several feet of ordinary garden hose were used at this point. The hose was laid across the road when the tank was being filled and removed and hung on a nearby fence post when not in use. Before doing this, permission should be obtained from the local highway authorities.

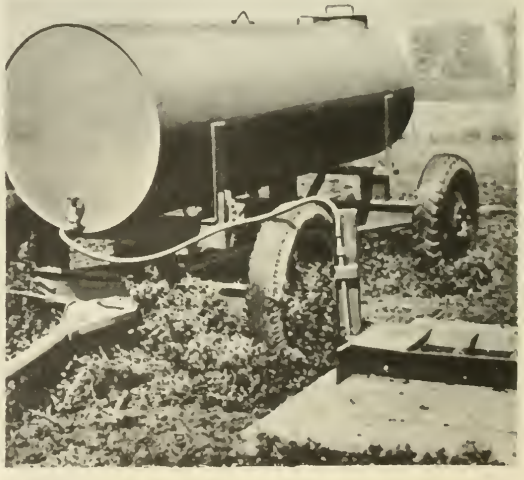
A. M. Wettach, Mt. Pleasant, Iowa

Watering Trough for Sheep Made of Tub and Odd Parts

A watering trough suitable for sheep can be made out of a washing-machine tub and a few odd pieces of plumbing equipment. Mount the tub on a water pipe, as shown in the photograph below, and fit it with an automatic float valve to keep the water level constant. An electrical heating unit may then be suspended in the water and plugged in during the severe winter months to keep the water from freezing.

Trough Filled Automatically From Tank Wagon

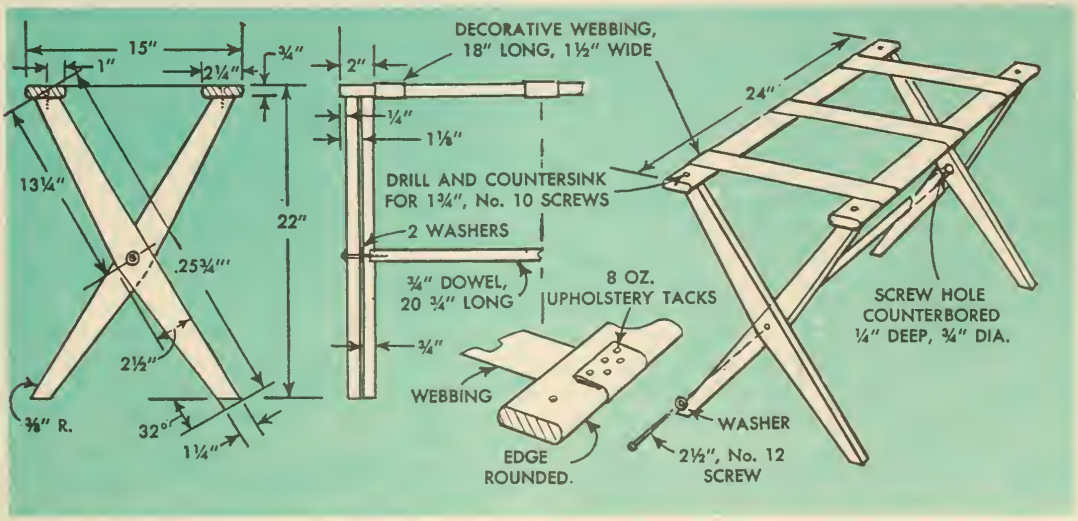
To keep hogs on pasture supplied with fresh water with a minimum of attention, one farmer has connected a trough to a tank wagon by means of a hose. A float valve in the trough holds the water level low so that a steady supply prevents an accumulation of water from becoming stale. Bolted to a slightly elevated platform, the trough is held level and is kept free of mud and trash.



Luggage Rack For Your Guests

WEEK-END GUESTS will appreciate your thoughtfulness when you place a luggage rack at their disposal. Having a place to lay open a two-suiter, other than on the bed, is a real convenience. You can make a couple of these racks in a few hours, following the details given below. The legs can be mass-tapered by using a tapering jig in conjunction with the saw fence. You will notice that the legs taper only along one edge. Since the rack must support a heavy load, it should be made of hardwood, such as birch or oak, and also glued and screwed securely together. Washers placed over the pivoting screws provide clearance between the legs. Three strips of decorative plastic webbing, stretched across the top, limit the spread of the legs. Tacking is done on the underside of the top members.

John Bergen, Glenbeulah, Wis.



Lumber Alignment Chart

Table below is used in conjunction with alignment charts to figure number of identical timbers needed

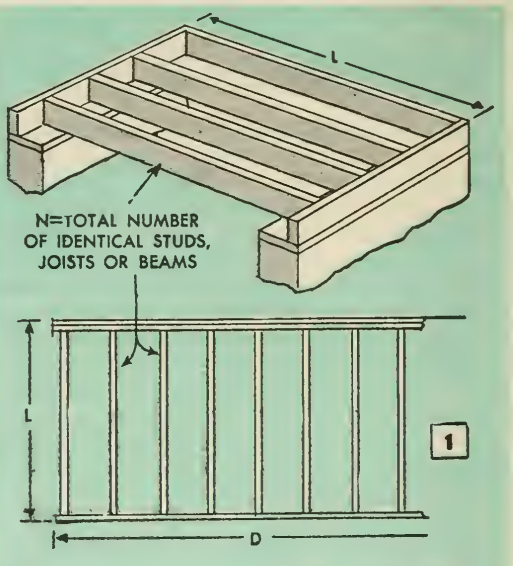
THE USE of alignment charts will reduce the ordinarily time-consuming job of figuring the amount of lumber needed for a construction job to a simple matter of holding a straightedge across the correct figures on the charts.

Because lumber generally is sold on the basis of so many dollars per thousand board feet, the alignment charts permit converting building dimensions and lumber sizes into board feet. It then is a simple matter to convert board feet to dollars and cents.

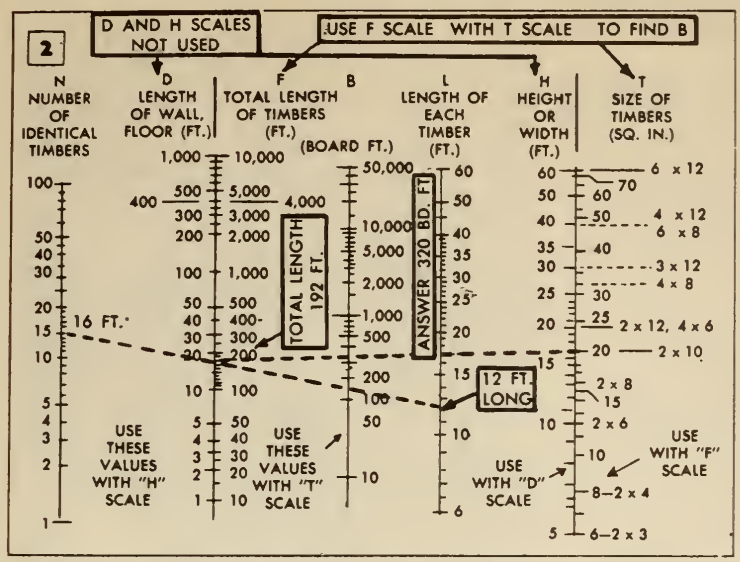
When using the alignment charts, it is necessary to know the number of identical timbers. Use of the table in Fig. 1 permits doing this quickly. The formula used in the table is: N, the number of timbers, equals D, the length of the wall or structure, multiplied by S, which represents the spacing used, plus 1, plus X. The X factor must include 2 for each door or window opening, plus 2 more if double studs or beams are used in the ends of the structure.

Lumber requirements fall into two general categories. One covers "dimensioned lumber" used for framing, such as 2 x 4 studs and 2 x 8 joists. The second includes 1-in. lumber, commonly used for sheathing, siding and flooring.

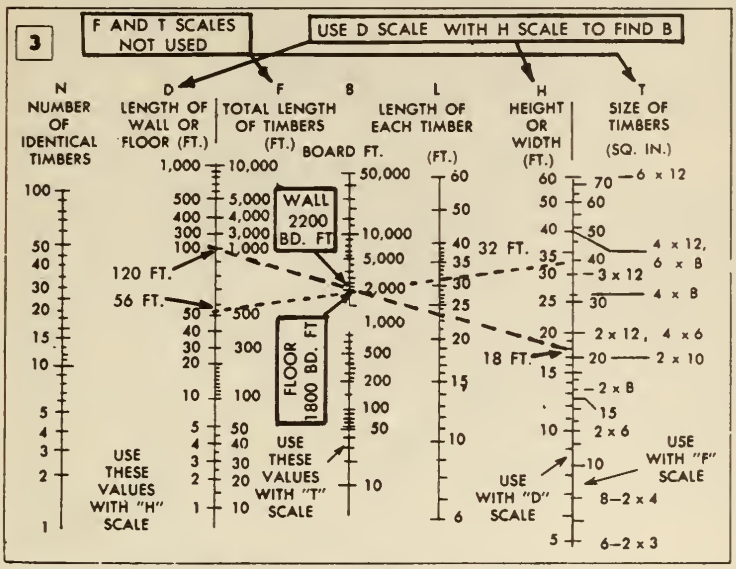
Fig. 2 shows an example of using the alignment charts to figure the board feet



FOR UNIFORMLY SPACED STUDS TO COVER A DISTANCE "D" N=(D×S)+1+X		
SPACING CENTER TO CENTER	S	X
12"	1	2 IF ENDS ARE DOUBLE, PLUS 2 FOR EACH DOOR OR WINDOW OPENING
16"	¾	
24"	½	



The example shown above indicates the required timbers in board feet



The board feet of siding that are needed is shown in the above example. In Fig. 4, below, is the factor table for finished 1-in. lumber shapes

	COMMON BOARDS	TONGUE-AND-GROOVE ROUGH FLOORING	BEVEL SIDING
4	NOMINAL WIDTH / ACTUAL WIDTH = (NOMINAL–⅞")	NOMINAL WIDTH / ACTUAL WIDTH = (NOMINAL–¼")	NOM. WIDTH / ACT. WIDTH / EXPOSED WIDTH = (NOMINAL–1½")
NOMINAL WIDTH	TRIMMING AND OVERLAP FACTOR		
4	1.10	1.23	
6	1.07	1.14	1.33
8	1.05	1.10	1.23
10	1.04	1.08	1.18
12	1.03		1.14

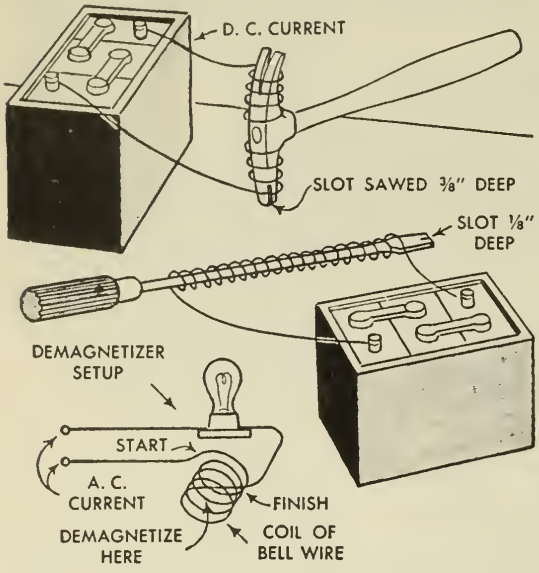
required when 16 joists 12 ft. long are needed, the joists to be 2 x 10s. The figure 16 (number of joists) is located on the N scale and a straightedge is placed from it to the number 12 (length) on the L scale. Total footage is indicated at the point the straightedge crosses line F, in this case 192 linear feet. Next, the straightedge is placed on 192 ft. on the D line and across to the T line on 2 x 10. The point at which the straightedge crosses the B line indicates the number of board feet required. If a 2 x 10 was not indicated on the T line, an equivalent cross-sectional area would be used, in this case 20 (2 x 10).

Fig. 3 shows an example of using an alignment chart to figure the amount of sheathing required to cover the four walls of a house. The house is 28 ft. wide and 32 ft. long, with a wall height of 18 ft. On chart D is 120 ft. (2 x 28 plus 2 x 32), and H is 18. When a straightedge is held between these points, board feet can be read directly from the B scale.

The nominal size of lumber is its unfinished size. Finished lumber bought at a yard is considerably reduced in dimension, for example a 2 x 4 actually measures about 1⅝ in. x 3⅝ in. The reduced dimension makes no difference in dimensioned lumber used for framing, but does affect sheathing, siding and flooring where a definite area must be covered. Fig. 4 shows the approximate amount lost in trimming and overlap for several lumber types. The number of board feet determined by using the chart must be multiplied by the proper trim or overlap factor to get the number of board feet of finished lumber. ★ ★ ★

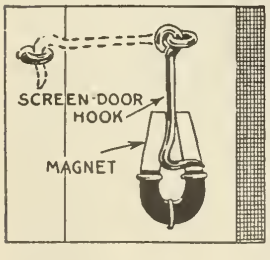
Tools Permanently Magnetized With Battery and Wire

If you have a screwdriver, tack hammer or other tool that you wish to magnetize, this may be done easily with a storage battery and a length of heavy-gauge, flexible wire. First, slot the face of the tool with a hacksaw to provide two poles, similar to those on a horseshoe magnet. Then, form



the wire into a coil of about 10 turns and fasten each end to a storage-battery post. Insert the tool through the coil, allowing it to remain there approximately 10 min. Rub it lightly on a piece of iron or steel during this period. To make a demagnetizer, take a coil of bell wire and connect it in series with a lamp bulb on a.c. current. Pass the tool through this coil several times, testing it for magnetism each time until the tool is completely demagnetized.

Swinging of Screen-Door Hook Avoided by Magnet

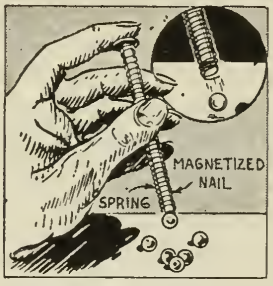


To prevent the hook on a screen door from swinging between the frame and door when the latter closes, you can employ a small permanentmagnet as indicated. Wire staples hold the magnet under the hook in the position shown.

Tin-Can Tops Easily Removed With Magnet

When using a can opener of the rotary type where the lid has a tendency to drop down inside the can after it has been cut away, you will find a small magnet handy to hold a lid. When the latter has been almost cut away, just place the magnet against it, as indicated in the photo, and then complete the cutting, after which you can easily lift it up.

Assembling of Small Ball Bearings Aided With Magnetized Nail



Small ball bearings or other steel parts may be handled easily for assembly work by means of a magnetized nail and a coil spring. The spring, which is of a size to just fit over the nail, is stretched so it is slightly longer than the nail. Held as shown, the nail is pushed out of the spring to pick up a bearing, which is then pushed off the nail end by releasing the spring.

Magnet Holds Lettering Brush In Cleaning Fluid

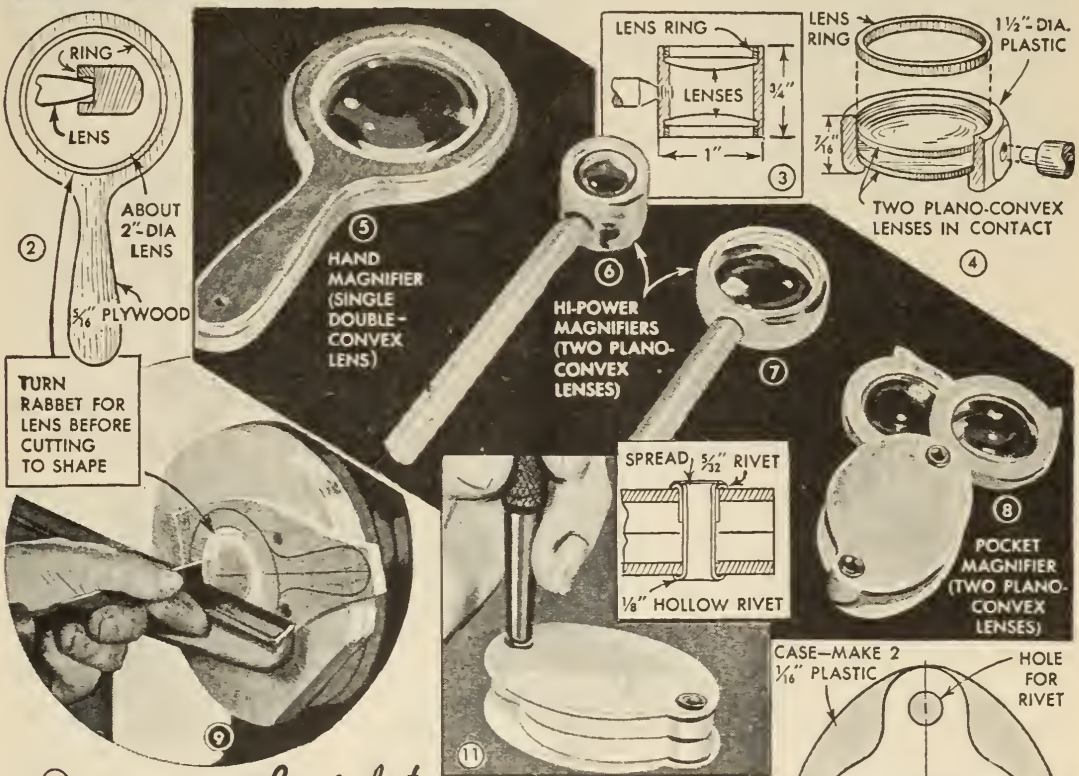
A fine-pointed lettering brush can be kept in a glass of cleaning fluid so that it will not rest on the bottom and destroy its shape if you use a toy magnet over the edge of the glass to hold the brush as indicated in the sketch at the right. The magnet will attract the steel ferrule of the brush and hold it in place securely so that the bristles remain at any desired depth in the liquid.

Make Your Own MAGNIFIERS

① FINDING FOCAL LENGTH OF LENS

MAGNIFIERS are fun to make and find dozens of practical uses in home, shop or office. Lenses with chipped edges are quite satisfactory and by purchasing these factory rejects you can make really nice glasses for as little as 20 cents.

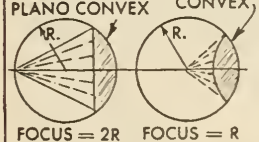
Lenses used in making magnifiers are of the plano-convex and double-convex type, as shown in Fig. 10. The focal length of a lens usually is known when you buy it, but it is an easy matter to determine the focus if you get lenses mixed. This is done as shown in Fig. 1. Move the lens up and down along the edge of a ruler until the light rays focus to a sharp, small



Lens data

LENSES

PLANO CONVEX — DOUBLE CONVEX



ALL SIMPLE LENSES ARE BASED ON A CIRCLE. NOTE THAT THIS IMPOSES DEFINITE LIMITS ON FOCAL LENGTHS FOR ANY SPECIFIED LENS DIAMETER

MAGNIFICATION

THE NORMAL SEEING DISTANCE OF THE EYE IS 10" ANY LENS WHICH SHORTENS THIS DISTANCE GIVES MAGNIFICATION.

HENCE: $M = 10'' \div FOCUS$

EX: 1" FOCUS

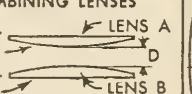
$M = 10 \div 1 = 10X$

10" = 254 MILLIMETERS. IF FOCUS IS GIVEN IN MILLIMETERS:

EX: 50 MM. FOCUS

$M = 254 \div 50 = 5X$

COMBINING LENSES

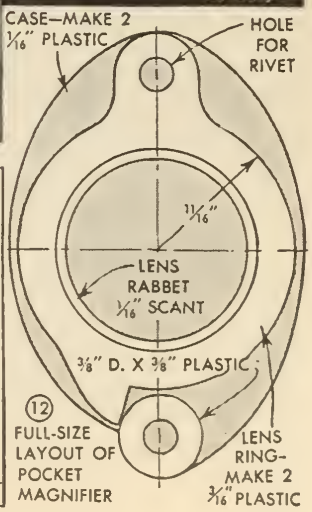


WHEN TWO LENSES ARE USED TOGETHER, USE THIS FORMULA TO FIND FOCUS

$$F = \frac{\text{FOCUS OF A} \times \text{FOCUS OF B}}{FA + FB - D}$$

EXAMPLE FROM DRAWING IF D = 10 MM.

$$F = \frac{50 \times 40}{50 + 40 - 10} = \frac{2000}{80} = 25 \text{ MM.}$$



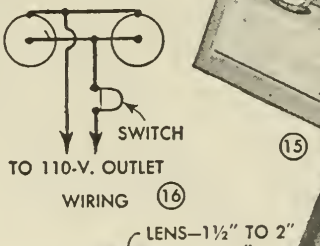
VIEW THROUGH ILLUMINATED MAGNIFIER (ABOUT 3X) (13)

ILLUMINATED MAGNIFIERS ARE VERY HELPFUL ON FINE DETAIL WORK., LENS SHOULD BE 1½" TO 2" DIAMETER FOR TWO-EYE VISION. MAGNIFICATION 2 TO 4X TO SUIT (14)

area, then read the focal length on the ruler. The best light to use for checking the focus is sunlight, but with small lenses you can get accurate results with an electric light, provided it is several feet away from the lens.

It is important to know the focal length of a lens because this determines its magnification. The shorter the focal length the greater the magnification. You can find the power of any single lens or any two lenses combined by applying the simple calculations given in Fig. 10. Combining lenses always gives a shorter focus. If two lenses of the same focus are placed in contact the combined focus will be one half of the individual focus.

Simple hand and pocket magnifiers are shown in Figs. 5 to 8. The frame for the hand magnifier, Fig. 5, can be wood or plastic. A turned ring cemented in place holds the lens securely as can be seen in Figs. 2, 3, 4 and 9. Magnifiers shown in Figs. 6 and 7 use two plano-convex lenses. The handy pocket magnifier, Fig. 8, is diagrammed full size in Fig. 12, while Fig. 11 shows how the assembly is made with hollow rivets. In this unit lenses are a snug, press fit in the plastic mounts and are simply cemented in place without using a retaining ring. The lenses are



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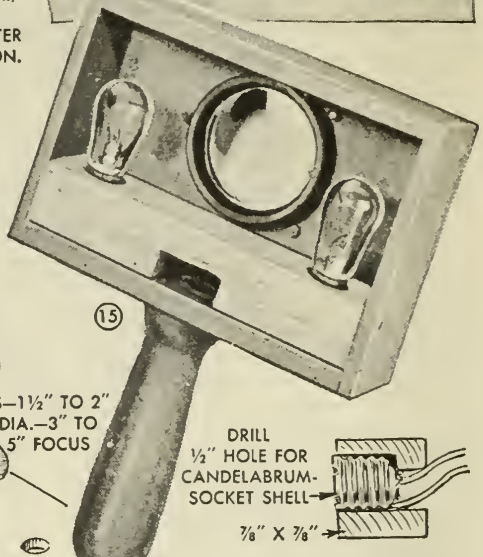

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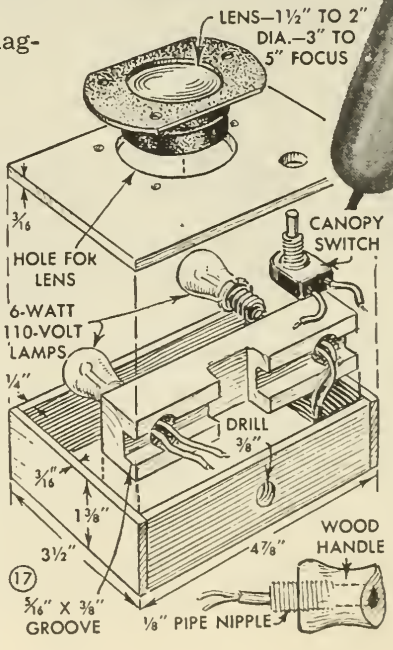
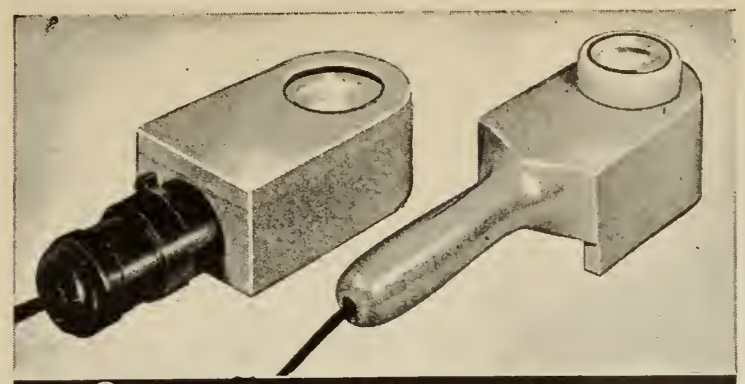


(17)

plano convex, arranged so that their curved surfaces face each other.

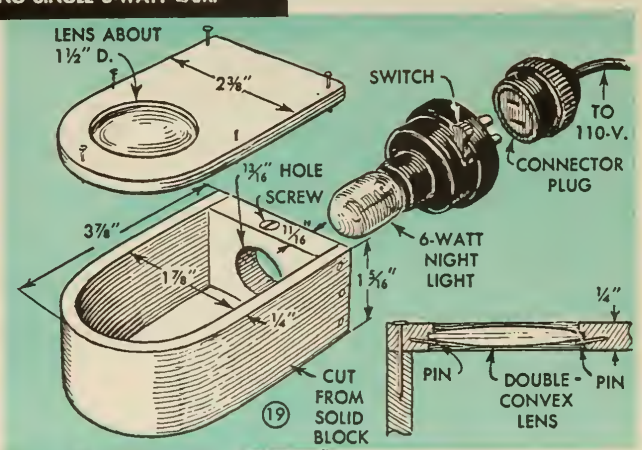
Plano-convex lenses should be used whenever possible in a combined lens system and always with the curved sides facing each other. This assembly gives good correction and a clear, flat field. Double-convex lenses also can be combined, but the correction is not so good. The double-convex lens is a logical choice for single-lens magnifiers as you can



⑱ TWO ILLUMINATED MAGNIFIERS USING SINGLE 6-WATT LAMP

look through either way and get the same result. If a single plano-convex lens is used, have the flat side next to your eye if you use the glass close to your eye; if you hold the magnifier a distance away from your eye have the curved side facing you. Check this yourself and you will note there is considerable distortion if these suggestions are not followed.

A magnifier is useless unless there is good light on the object being examined. Hence, it is logical to combine a light directly with the magnifier. A good unit of this kind is shown in Figs. 13, 14 and 15 and detailed in Fig. 17. Fig. 16 diagrams the wiring. The lamps used are standard 6-watt, 110-volt with candelabrum screw bases; sockets are candelabrum socket shells. If you have any trouble buying these you may be able to solve your problem by breaking up an old Christmas-tree string. Another way is to solder the wires directly to the lamp, but this means, of course, that you have to tear the box apart when a lamp goes bad.



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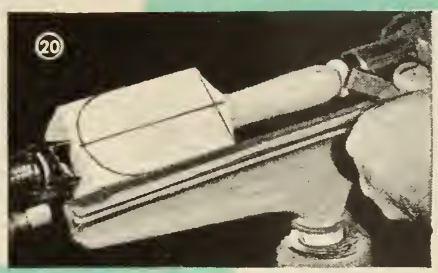


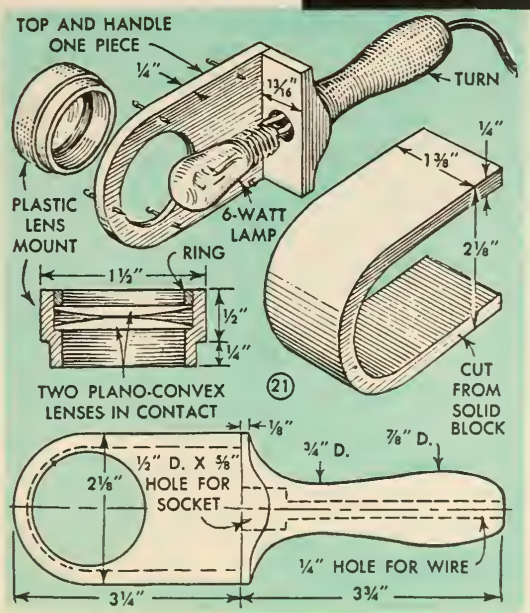
⑳

For certain kinds of work, you may want this magnifier on a permanent stand. The best mounting is a 10 or 12-in. flexible gooseneck, as can be seen in Fig. 14. The gooseneck has a ⅛-in. pipe coupling at either end, making it easy to attach a base and the magnifier by means of pipe nipples.

Two illuminated magnifiers each using a single lamp are shown in Fig. 18. The night-light socket shown in one of the units, Fig. 19, can be purchased at most electrical stores. Discard the small plastic shade that comes with it and hold the socket in a wooden frame by driving in a machine or wood screw to make contact with the groove in the socket. The top and handle for the style shown in Fig. 21 are worked in one piece, the handle being turned first, as shown in Fig. 20.

Lenses for these illuminated magnifiers should be at least 1½ in. in diameter if you want to use them for two-eye vision. It is best to keep the magnification rather low —two or three power will be plenty and at this magnification you will get a wide, flat field without distortion.

Other useful magnifiers are shown in



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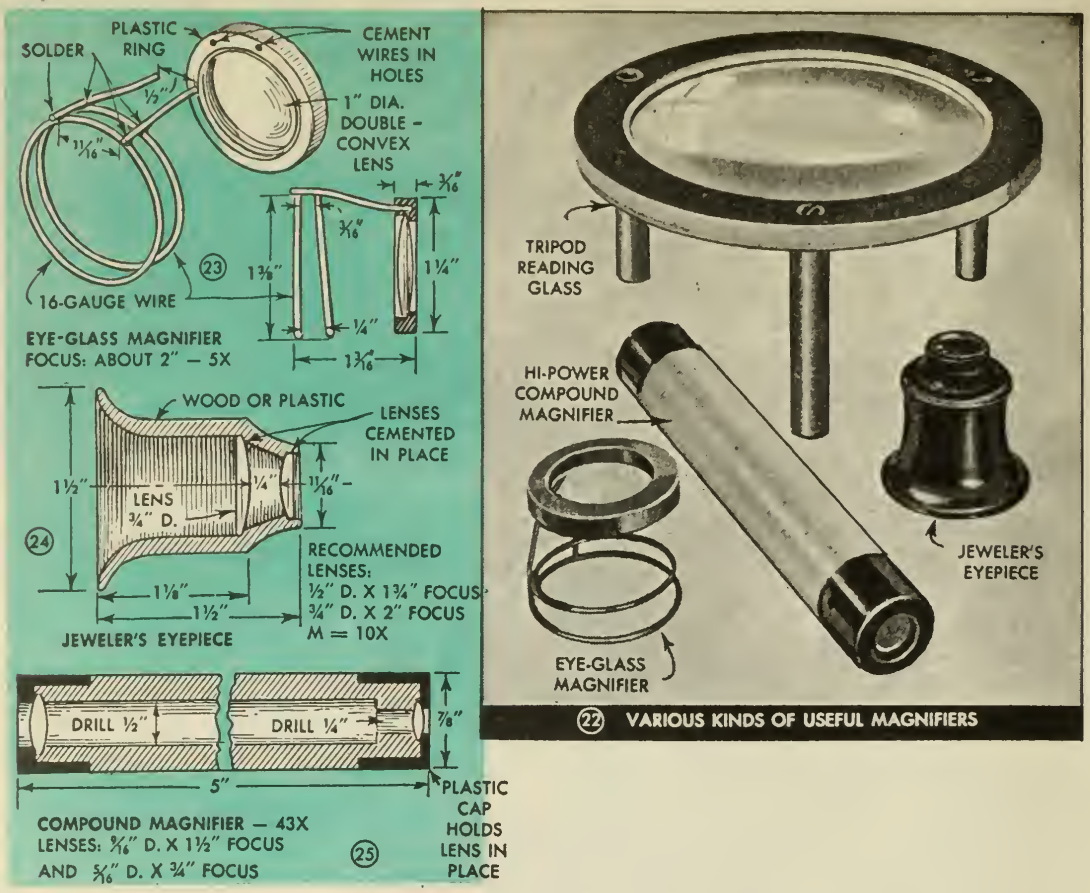


Fig. 22. The tripod style is excellent for retouching or other jobs where a fixed focus over the work is required. The lens should be 2 to 4 in. in diameter and of low magnification. If you wear glasses you will like the little eye-glass magnifier detailed in Fig. 23. It slips over one lens of your glasses and you can look through it or under it at will. The lens focus should be about 2 in. for 5X magnification. For critical examination of small objects the jeweler's eyepiece, Fig. 24, makes a nice glass. It can be turned in either wood or plastic. The recesses for lenses should be made for a snug fit, the lenses being cemented in place with transparent adhesive. This glass should be made 8 to 10X. It is used close up, being clamped directly to the eye in monocle fashion. If you want extremely high magnification the best simple instrument is the compound magnifier shown in Fig. 25. It is really a low-power microscope in which an image is picked up and magnified by one of the lenses and then further magnified by the second lens. The final image will be upside down. The big lens is commonly the eye lens, but you can use it either way with same magnification. In a system of this kind the eye lens is calculated for magnification the same as any other magnifier; that is, 10 in. (the eye's normal seeing distance) divided by the focal length of the lens. The object lens is calculated by dividing its focal length into 5 (the length of the tube). The two powers thus obtained are then multiplied to get the total magnification. Plastic caps shown can be bottle caps, while the tube itself can readily be turned and bored in wood with the ends recessed to take the lenses.

Foreign Particle in Eye Located with Aid of Magnifying Glass

A foreign particle in the eye that is hard to locate often can be seen with the aid of a magnifying glass held in front of a mirror. Get as close to the mirror as possible. The hand that holds the glass can pull down the lower eyelid, thus leaving the other hand free to remove the particle.

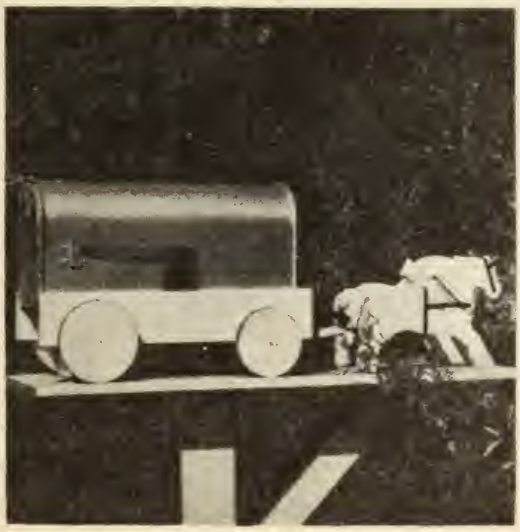
MAILBOX ART PLEASES PASSERS-BY

ROCKING HORSE uses the rural box as the body. In this one the box is supported by four posts, or legs, cut from thin-walled tubing and attached to a wooden platform. The head is scroll-cut from light plywood and the tail is made from a hank of frayed hemp. When decorating mailboxes, don't attach anything to the drop front of the box that makes it difficult to open and close.

CHINESE JUNK is built up around the mailbox, utilizing the box as the galley. Carefully made its cleverness is sure to catch the eye. Hull is carved from thick pine plank. The sail can be made from a fabric, of course, but is more durable if cut from thin sheet metal. Paint the whole affair in bright, durable colors to add interest and protect it against weathering.

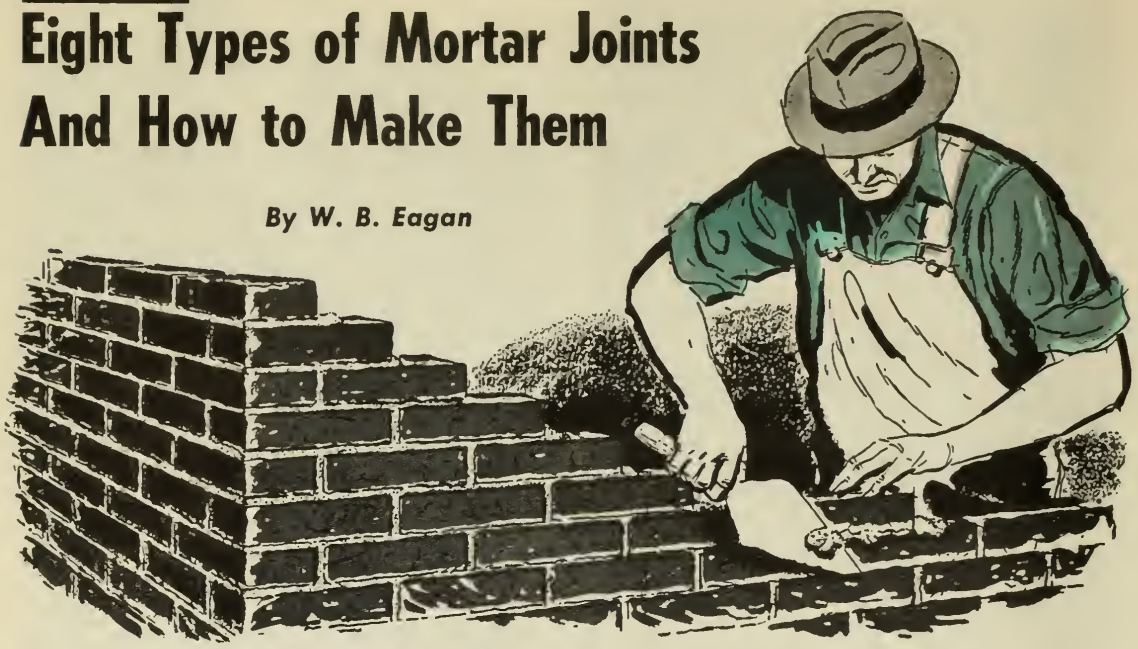
COVERED WAGON can light up the memories of oldtimers still living. Here the mailbox serves as the canvas cover of the wagon. Wheels can be plain disks as pictured or you can go a step farther toward realism by making spoked wheels. Horses are simply profiles cut from ⅜-in. outdoor plywood. Frayed rope forms tails, bits of leather the harness.

HOUN' DOG can be anybody's dog, of course, but this one is very much an individual and rather proud of it, as you can see. Remember your rural mail carrier. He opens and closes a lot of boxes along the way and he delivers your mail every day, rain or shine. Attach the head of the dog so that it does not interfere with opening and closing the drop lid of the box.



Eight Types of Mortar Joints And How to Make Them

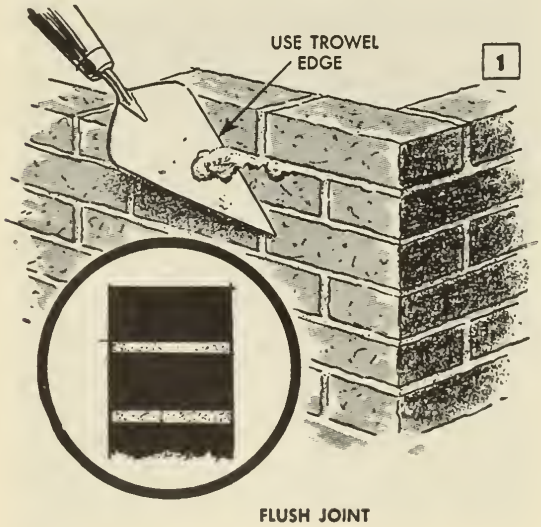
By W. B. Eagan



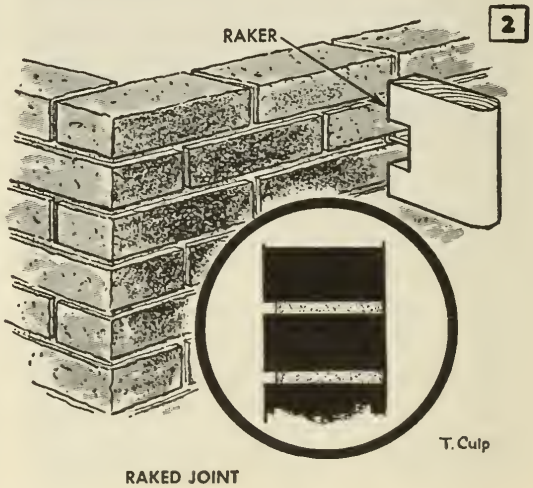
WHETHER YOU PLAN to build a brick-veneer garage or just a small planter box, it will pay to know how to finish the mortar joints in a way that not only will result in a pleasing appearance, but also produce a watertight surface on all exterior construction.

One of the quickest and most easily applied mortar joints is the "flush" joint, Fig. 1. You can apply a flush joint simply by cutting off the excess mortar from the vertical and horizontal joints with the edge of the trowel. No other operation is necessary. Although it is used extensively on interior work, the joint is not recommended for exterior construction. When making it, many voids and rough spots tend to remain on the surface of the material to readily absorb moisture that may be transmitted to the interior of the wall.

"Raked" joints produce dark shadows that accent the pattern of the masonry, Fig. 2. To make this joint, the extruded mortar is first cut off flush with the brick, using a trowel. After a lapse of a few minutes, when the mortar begins to congeal, the mortar joint is raked out to the desired depth. The vertical joints are raked out first, followed by the horizontal ones. Professional tools, such as a steel raker or jointer can be used for tooling (finishing with a tool) this type of joint, but a raker made from a hardwood block with a nail driven in a notch cut in one edge of it, will work just as well as shown in Fig. 2. The depth to which the nail is



FLUSH JOINT



RAKED JOINT

driven into the block determines the depth or recess of the mortar joint. To complete this type of joint, a square tool of the same width as that of the joint is run over the mortar to compress it and fill all voids. Another method of applying the raked joint is to force out the mortar before it congeals using a jointer tool having a square end. When the mortar is slightly congealed, the excess is removed from the outer surfaces of the brick with a stiff-bristled brush.

A type of joint that is difficult to make and which requires considerable preparation, is the "stripped" joint, that results in a convex-surfaced mortar joint, Fig. 3. When making the joint, a wooden strip with a concave surface cut on one side edge is placed flush with the outside edge of the preceding course of brick. The mortar is then placed on the brick for the full length of the strip and flush with the top of it and the next course of brick is laid. Only the ends of the brick are coated with mortar before positioning them on the work. When the mortar becomes slightly congealed, the strip is removed and the vertical joints are tooled with a raker.

A less dramatic-appearing joint than some of the others but the best from a standpoint of keeping out moisture and ease of application, is the "concave" joint shown in Fig. 4. This type of joint should be applied with sufficient force to press the mortar tight against the brick on both sides of the mortar joint using a cylindrical-surfaced tool that is slightly larger than the joint. Such tooling helps to seal cracks between the mortar and brick that may have been left when the extruded mortar was removed. Concave joints should always be used for face brick, unless the architecture requires some other type of finish. No other type of joint provides as much protection against entrance of water.

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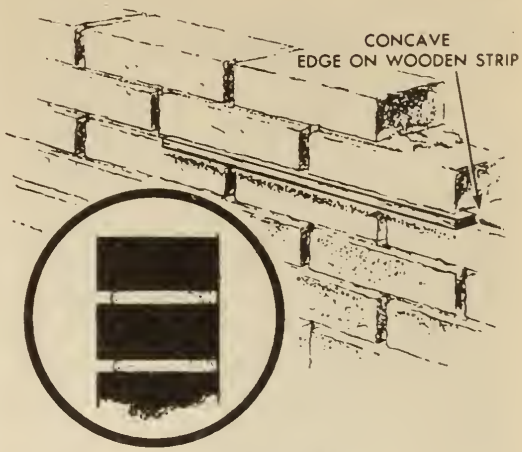

CONVEX JOINT

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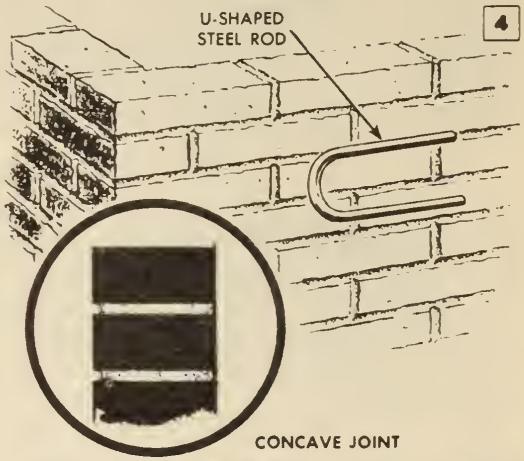

CONCAVE JOINT

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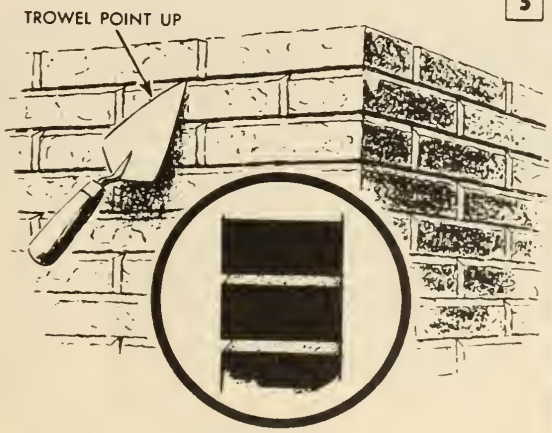
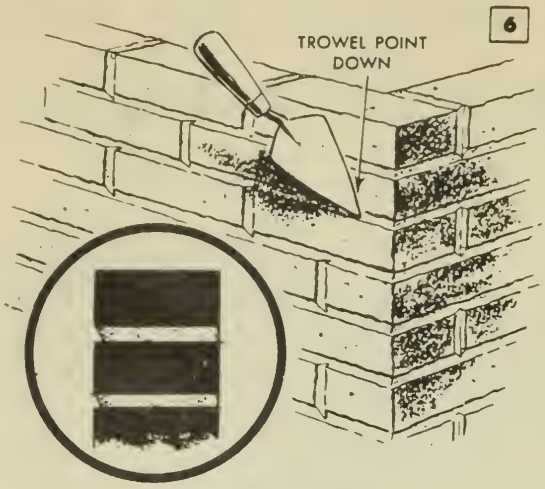
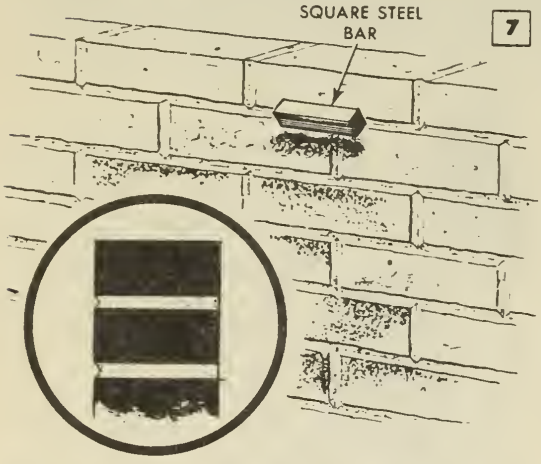


WEATHERED JOINT



STRUCK JOINT



V-JOINT

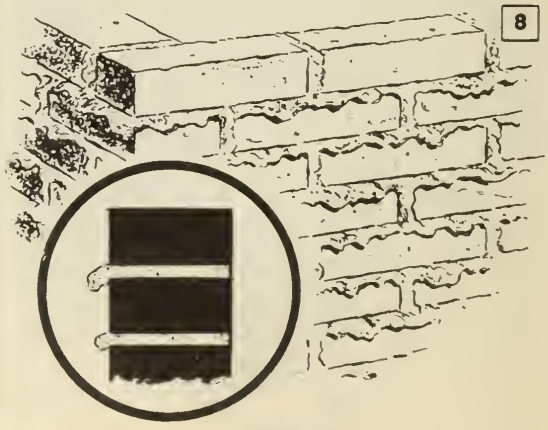
The "V"-joint is made in the same manner as the concave joint, except that a short length of ½-in. square steel bar or an appropriate jointer tool is used for surfacing the mortar joint instead of a cylindrical-shaped one as in the case of the concave joint, Fig. 7. When doing this, the tool is held in the position indicated and drawn along the horizontal and vertical mortar joints. If you want to accent the horizontal mortar lines, do them last. If the vertical lines are to be accented, do them last.

When making a "struck" joint, the mortar is permitted to congeal for a few minutes, after which the point of the trowel is quickly drawn along the joint. The trowel must be held at a sharp angle when doing this so that only the point comes in contact with the soft mortar as in Fig. 6. The vertical joints are made first, followed by the horizontal ones for neater joints. An undesirable aspect of a struck joint is that a shelf is left to collect water.

For some types of construction, an interesting play of light and shadow can be effected on a walled surface through application of the "weathered" joint, Fig. 5. This joint is made in the same manner as the struck joint, except that the point of the trowel is reversed so that it forces mortar in at the top of the joint, leaving a slight overhang on the lower edge of each brick course. When making this joint, care must be taken to pack mortar solidly against the top brick of the joint to obtain a good bond.

For good results, never change the position of brick once the mortar has begun to set.

The easiest joint of all to make, is the "extruded" joint as shown in Fig. 8. The mortar that is forced out as the bricks are laid, is not trimmed off but is simply left to harden in its extruded form. For exterior use, raked and extruded joints are best suited to a dry climate since the ledges formed by them tend to hold rain, snow, or ice that may enter voids in the mortar and cause the wall to leak. ★ ★ ★



EXTRUDED JOINT

TUCK POINTING

It's important to keep mortar joints between bricks watertight to avoid costly repairs

WHETHER your home is of brick or of frame construction with only a brick chimney, you no doubt realize the necessity for tuck pointing; that is, renewing the loose and crumbling mortar in the joints between the bricks. This is one phase of home-repair work in which you can save a sizable amount of money by doing the job yourself, and it does not require any special skill or know-how.

The primary cause of the loosening of the mortar is the entrance of water into hairline cracks where the bricks have pulled away from the mortar. Constant wetting, especially during the spring and fall, weakens the mortar and, during the winter, the freezing of water in the cracks causes the mortar to crumble. The result, of course, is further deterioration and, if not corrected, results in a dangerous weakening of the structure. All brick surfaces are subject to mortar erosion, but the problem is most likely to be encountered in the chimney brickwork, Fig. 1, and on the walls under parapet copings, leaky eaves troughs and large windows, as well as at any point where brickwork comes in contact with moist earth. Stopping water leakage at its source may require only calking of the

Above, before chimney is tuck pointed, the cap is examined and all cracks are sealed to keep out water. Below, remove all loose and crumbling mortar, brush away the dirt and saturate the brickwork thoroughly

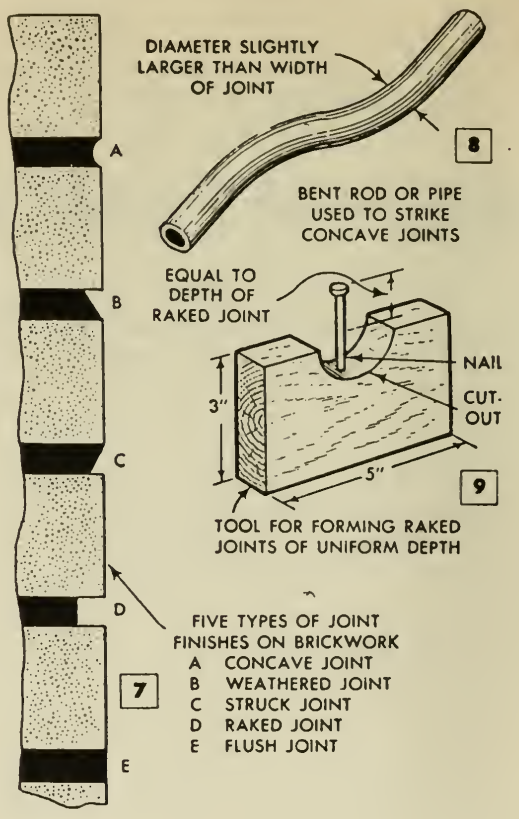
Edge of pointing trowel is pressed over mortar to "strike" the joints, making them compact and smooth

crack through which it is entering. Sometimes this can be done with an application of roofing cement as in Fig. 2. However, occasionally it is necessary to replace a flashing, repair a cracked chimney cap or renew a wall coping.

Danger sign: A white frostlike deposit on the outside of the brickwork is an obvious indication that water is penetrating the mortar joints. The deposit, called efflorescence, is caused by soluble salts being washed out of the bricks and mortar, and can be removed by scrubbing the affected surfaces with a solution of muriatic acid, 1 part, and water, 10 parts, using a fiber brush to apply the solution. All traces of the acid should be rinsed from the brickwork with a garden hose. *Caution: Avoid getting the acid solution on the skin or the clothing. Wear rubber gloves while working.*

Cleaning and soaking: Before tuck pointing, remove all loose mortar with a cold chisel or with a screwdriver and hammer, Fig. 3. Avoid chipping out solid mortar but remove that which can be pried out by hand or with only light tapping. Then brush the dirt and dust away as in Fig. 4. Dry bricks quickly absorb moisture from fresh mortar, causing the mortar to congeal and preventing proper adhesion. To avoid this, thoroughly wet the brickwork before the mortar is applied, Fig. 5.

The mortar mix: Bags of prepared mortar can be obtained from most building-supply stores. Dry-mix the entire bag to be sure that the ingredients are uniformly distributed. Then put a small amount (as much as you will use in about an hour) in an old metal pail and, adding water a little at a time, mix thoroughly until the consistency is quite stiff. If you prefer, you can make your own mortar by mixing portland cement, 1 part, hydrated lime, 1 part, and clean, sharp sand, 6 parts—all measured by volume. For extra-strong mortar, use 3 parts of sand instead of 6 parts. Use the mixed mortar as soon as possible, as it



quickly becomes too stiff to work and will lose some of its strength each time it becomes necessary to add water. If you use a wooden mixing board, soak the board with water so it will not absorb moisture.

Applying the mortar: The only tools needed for filling the joints with mortar are a pointing trowel and a 6 x 12-in. hawk for holding the mortar, the latter being cut from sheet metal or hardboard. With the hawk, hold a small amount of mortar alongside a horizontal joint and work it in place with the trowel, Fig. 6. Try to avoid smearing the face of the bricks. After a few of the joints have been filled and before the mortar sets, finish them by pressing the trowel or other tool against the joints and drawing it across the surface of the mortar. This is called "striking" and is done vertically first, then horizontally.

Kinds of joint finishes: Fig. 7 shows a number of joint finishes commonly used. Concave joints, detail A, are usually considered the best since the mortar in them is packed tightly against both sides of the joint. They are easily made with a round-edged tool like the one pictured in Fig. 8. If the raked joint, detail D, is the one you must match, use a tool such as the one shown in Fig. 9. After recessing the joint with the raking tool, compact the mortar with a flat tool.

Photos and information courtesy Louisville Cement Co.

HOW TO LAY CONCRETE BLOCKS

IF YOU WATCH carefully when a professional is building a concrete-block wall, you will notice that he makes certain checks and measurements constantly. This is the secret of his professionalism, and an amateur who uses these same checks and measurements can do a job that is close to professional, both in appearance and strength. Patience is the amateur's substitute for the professional's experience.

The first step in building a wall is to square it with adjacent walls. The 3-4-5 triangle method can be used for this. One wall is measured off in 3 units, the adjacent wall in 4 units, and the hypotenuse of the triangle then must be 5 units if the corner is square. When constructing a wall, the corners are built up first, Fig. 12. Also, note particularly that in most of the photos a taut cord is used to check the straightness of the wall. This cord is used from the first course to the last. After the corners are built up, blocks with no mortar are spaced along the foundation between the corners to determine whether a shortened block will be needed, or a slight

"Course pole," straightedge marked off in 8-in. spaces, is used to assure courses are keeping correct height

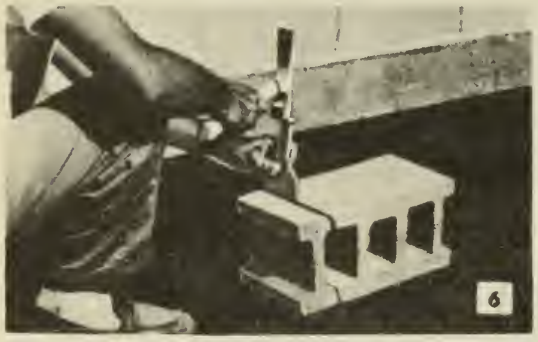
Trowel handle is used to tap blocks into alignment, using straightedge or edge of long level as a guide

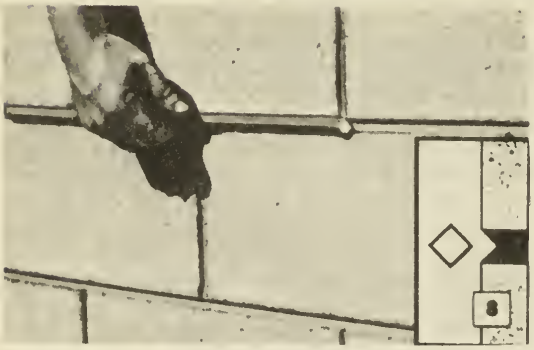
Full bed of mortar is spread on foundation to receive first course of block, assure maximum strength

Below, after block is carefully measured for right length it is cut by using mason's hammer and chisel

Mortar is spread on one end of block, which is pressed against adjacent block to form ⅜-in.-wide joint

Rough edges of cut block then are chipped with hammer to make them smooth as possible for appearance





After blocks have been set, and mortar is still plastic, forming tool is used to shape joints uniformly

Full bed of mortar under each block assures good bond. Excess is picked up with trowel and reused

As blocks are placed, trowel is used to remove excess mortar, trowel point compacts mortar in joints

When building up a pilaster (column) full, heavy bed of mortar assures complete bond under all blocks

increase or decrease in the average width is needed to fill out the length. Measuring off the length, Fig. 12, is another way of doing this. Note in Fig. 4 how a full bed of mortar is spread and furrowed along the foundation to assure a good bond for the first course of blocks. One end of each block, Fig. 5, also is mortared. Fig. 1 shows how each block is tipped toward the workman so he can see the edge of the lower block, then is slipped down and sideways against the adjacent block. Even when a chalkline is used, a straightedge should frequently be placed against the faces of the blocks to assure alignment, Figs. 3 and 17, and the tops should be leveled, Fig. 15. Occasionally place the level diagonally across a corner to make sure that the courses in adjacent walls are at the same level. Another check is to use a rule, Fig. 14, or a "course pole," Fig. 2, to make sure the courses are at the proper level and even with each other. The course pole is a straightedge marked off in 8-in. spaces. Concrete blocks are ⅜ in. short in length and height of a true dimension to allow for a ⅜-in. mortar joint. Vertical alignment also is checked, Fig. 16. These measurements and checks are made constantly, as the blocks must be moved before the mortar sets. If a block is moved after the mortar is no longer plastic, it must be removed, the mortar scraped away and fresh mortar applied. All blocks should be positioned with the thicker ends of the webs facing up, Fig. 18, to provide maximum mortar area. There are two ways to apply mortar, one by spreading, as in Fig. 20. The other way is to "wipe" it on as in Fig. 21. In all cases, enough mortar must be applied so that it is forced out on all sides, Figs. 10 and 13. For pilasters (a widened portion of the wall forming a vertical column) as in Fig. 11, the mortar bed is spread over the full faces of the blocks.

When fitting the closing block in a course —the last block to be fitted—it must have a full ⅜-in. joint on either end. Mortar is wiped on both ends before it is inserted and a trowel is used to compress the mortar firmly. When a block must be cut, measure it carefully to be ¾ in. shorter than the space into which it is to fit, and cut it neatly as possible, Fig. 6; then chip it to smoothness, Fig. 7. Excess mortar is wiped away with the trowel, Fig. 9, and returned to the mortar board to be reused. The trowel point is used to compact the mortar, then a forming tool, Fig. 8, is used to make all joints identical.

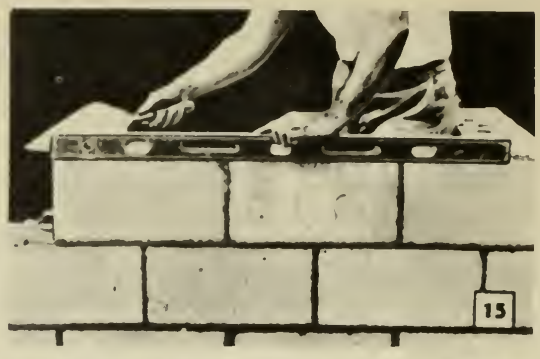
The trowel handle is the only tool used to tap the blocks into alignment, as in Fig. 19. If a tap of the trowel handle does not move a block, the mortar has set too firmly.

Marking off foundation, or laying out blocks without mortar, indiccates required spacing of blocks or need of partial block between built-up corners

HOW TO LAY CONCRETE BLOCKS

Enough mortar should be used under each block so that it is forced out under all edges, assuring a complete bond. Note the constantly necessary alignment cord that is moved up far each course of block

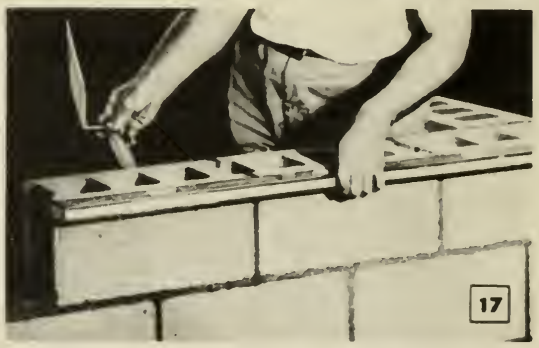
Rule, instead of course pole, can be used to assure that block courses are maintaining proper 8-in. height



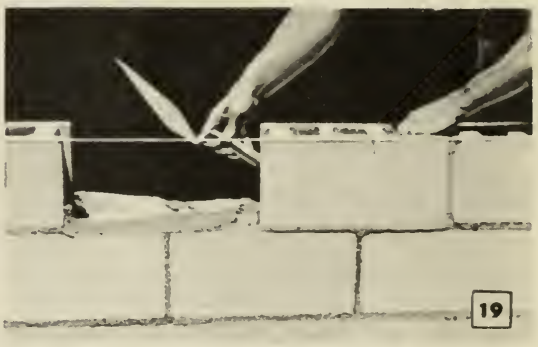
As each block is placed on mortar bed, it is leveled. For this job a long level is better than a shorter one

Each block also is plumbed when placed in position. Trowel handle gently taps the blocks into alignment

Long level is used here as a straightedge to align faces of blocks as they are fitted into the wall



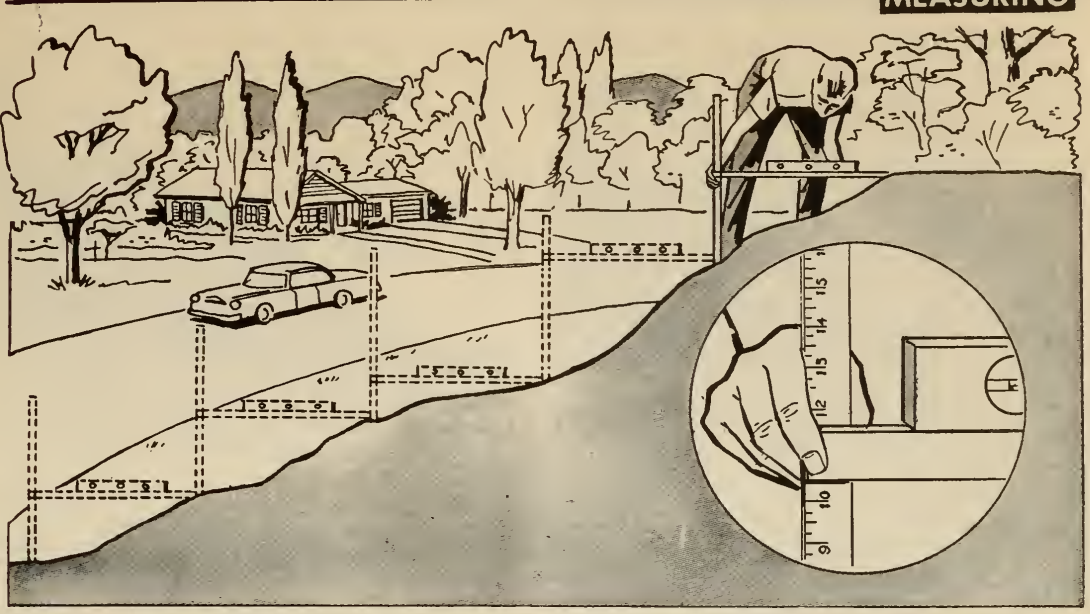
Cement blocks have thicker webs on one side. Thick webs are faced up to provide greater mortar area



Each block is tapped endwise to force out excess mortar and reduce vertical joint to standard ⅜ in.

Mortar can be applied in two ways. First way, and easiest for an amateur, is simply to trowel it on

Second method of applying mortar is to "wipe" it onto blocks from trowel as shown in photo below



1. Illustration and detail indicate how yardstick, level and length of wood are used to measure slope

MEASURING A HILLSIDE LOT

By Ralph Wellner

IN MANY CASES, building lots that have a beautiful view are on a hillside, which presents added problems to anyone looking for a site on which to have a home built, since the exact degree of the slope must be known by an architect when he designs a home for that location. Also, if the prospective home builder has already chosen a house plan, it will be necessary to determine whether that house can successfully be adapted to the hillside being considered.

It would be impractical, of course, to check the slope of every hillside shown to the buyer, and it would be prohibitively expensive to have a professional surveyor make a topographical plat of each lot, but with the simple method described in this article, it is possible to check the slope of locations that seem particularly desirable. the results are accurate enough that the elevation of a house plan can readily be superimposed on a scale drawing of the slope to determine the feasibility of constructing a particular house on that hillside lot.

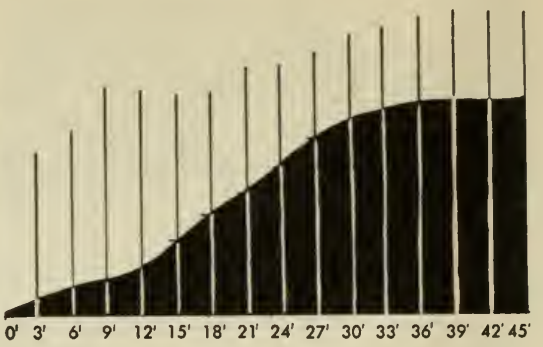
Tools required for the measurement of grade slope are: A yardstick, a 2 or 3-ft. length of wood and a level. Unless the slope is extremely steep — one that can hardly be climbed—a 3-ft. length of wood will be accurate enough. The three tools are used as illustrated in Fig. 1. Hold the yardstick as nearly vertical as possible, hold the 3-ft. stick horizontally from the slope to the yardstick and true it with the level. Read the figure on the yardstick which shows beneath the stick and write it down. Repeat this operation every 3 ft. either up or down the slope, from lot line to sidewalk or reverse, and make a table as shown in Fig. 2. The first column is the horizontal distance, in 3-ft. increments, the second column is the reading on the yardstick at each step. The third column is obtained by adding each new height measurement to the previous total, and thus shows the elevation at any point.

To get a complete picture of the slope, one that can be used to show how a house

2. SAMPLE TABLE

DISTANCE	HEIGHT	TOTAL
0	—	—
3′	16″	1′-4″
6′	11″	2′-3″
9′	7″	2′-10″
12′	19″	4′-5″
15′	27″	6′-8″
18′	23″	8′-7″
21′	25″	10′-8″
24′	25″	12′-9″
27′	29″	15′-2″
30′	20″	16′-10″
33′	10″	17′-8″
36′	5″	18′-1″
39′	2″	18′-3″

3. When measurements on table are converted to graph form, house-plan elevation can be superimposed



4. Figures from table are converted to graph form by marking scale measurements on vertical lines

would appear on the lot, as in Fig. 3, use the figures in the table to make a graph like the one in Fig. 4. First, draw a horizontal line on a large sheet of paper, then rule vertical lines every ¾ in. to represent the 3-ft. distances used to measure the slope. The graph will be ¼-in. scale, which means that if a 2-ft. stick were used, the vertical lines should be spaced ½ in. apart and measurements taken at 2-ft. intervals. Now, on the graph, measure up the scale a distance equal to the number shown in the total column opposite 3 ft. in the table. Do the same on the 6-ft. mark, and continue through all the vertical lines in the same manner. When all the vertical lines have been marked, carefully draw in a gently curving line to connect all the marks. You now will have a cross section of the hillside, and any house-plan elevation drawn to ¼-in. scale can be superimposed on this line to accurately determine how it will appear when the house is built on the lot, as in Fig. 3. ★ ★ ★

Measuring Distances by Pacing

Measuring such distances as the length of a driveway or the width of a plot of ground can be done fairly accurately by pacing, if the average length of your stride is known. To determine this factor, measure a distance exactly 100 ft. long and walk it several times, counting the number of steps required. As an example: If you walk the 100 ft. in 38 paces, your pace would be 2.63 ft. The number of your paces multiplied by this number then would produce the approximate length of any definite distance paced.—O. H. Hampsch, Oak Park, Ill.

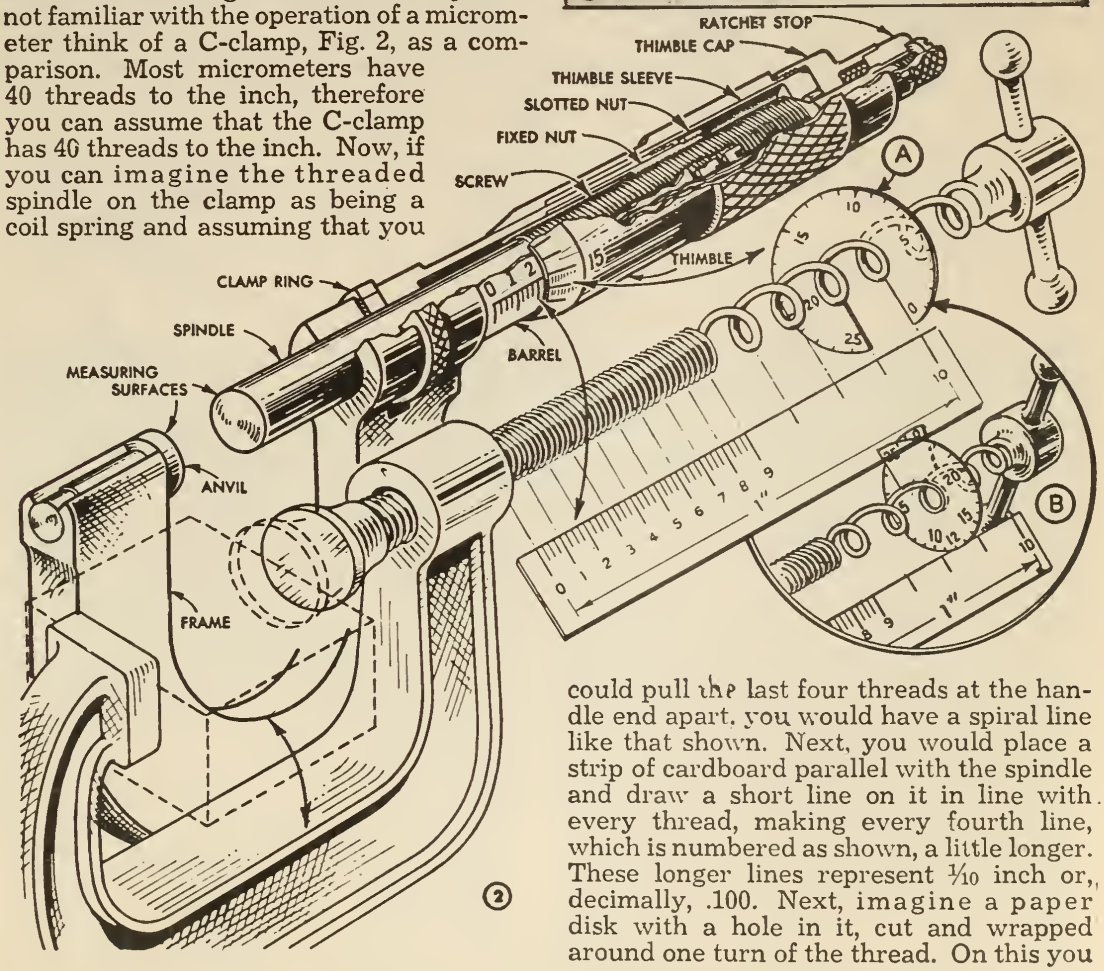
Wooden Strips Clamped Together Used for Measuring Doorway

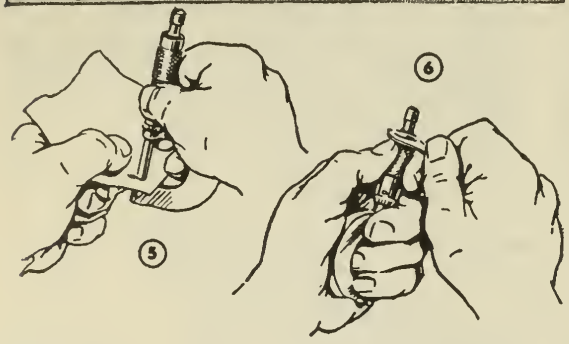
Have you ever tried to measure the exact distance between doorway moldings or other places where it is impossible to place a rule next to the points between which the distance must be determined? An easy way of doing this is to clamp two strips of wood together so that the ends are in contact with the surfaces between which a measurement is desired as shown in the photo. Then measure the clamped strips, or transfer the distance from the strips directly to stock, if a member must be cut to fit. Be sure the clamp screw is turned tight on the overlap of the strips when transferring a measurement. A small aluminum C-clamp is ideal for this purpose.

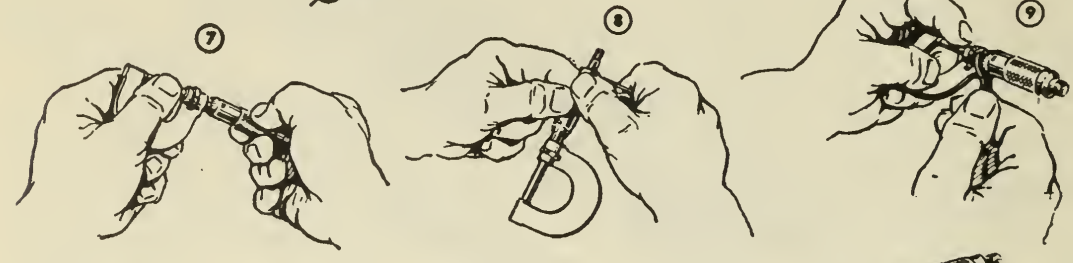
Wayne Judy, International Falls, Minn.

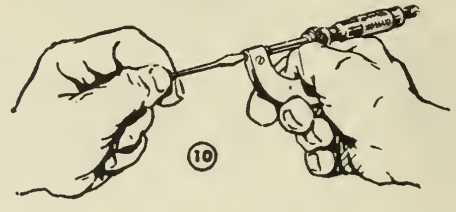
Care and Use of THE MICROMETER

ALTHOUGH micrometers are made in many shapes, types and sizes, the principles of operation are very much the same and should be understood thoroughly by anyone attempting to clean or adjust these delicate measuring instruments. If you're not familiar with the operation of a micrometer think of a C-clamp, Fig. 2, as a comparison. Most micrometers have 40 threads to the inch, therefore you can assume that the C-clamp has 40 threads to the inch. Now, if you can imagine the threaded spindle on the clamp as being a coil spring and assuming that you could pull the last four threads at the handle end apart, you would have a spiral line like that shown. Next, you would place a strip of cardboard parallel with the spindle and draw a short line on it in line with every thread, making every fourth line, which is numbered as shown, a little longer. These longer lines represent 1/10 inch or, decimally, .100. Next, imagine a paper disk with a hole in it, cut and wrapped around one turn of the thread. On this you









think of 25 equally spaced lines drawn as at A in Fig. 2. This compares with the thimble of the micrometer shown in the cutaway view in the background of Fig. 2. Turning the handle on the C-clamp one turn to the right moves the jaw of the clamp one thread, or 1/40 inch, closer to the other jaw. Decimally this would be .025. By turning the handle one mark on the paper disk A the jaw would move 1/25 of 1/40 inch, or .001.

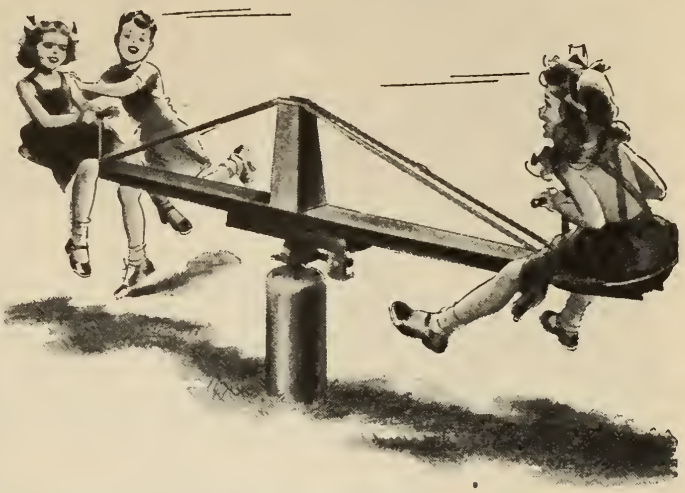
Now, if you turn the handle until the C-clamp jaws lightly touch the "block" indicated by the broken lines, the paper disk will advance to the position shown in detail B, Fig. 2. To read this imaginary "mike," you first count the number of lines representing 1/10 inch and write it decimally .900; then the 1/40-inch lines, which is 3/40 or .050, and finally the paper-disk lines 12/25 of 1/40 inch, or .012. The sum of these values is .962 of an inch, which is the thickness of the block. Of course, it would be impossible to measure within .001 inch with an ordinary C-clamp, but by studying the comparisons you will have a better understanding of the micrometer mechanism.

If the micrometer does not give a correct reading due to play in the threads, adjust it with the slotted nut, Fig. 2. Remove the screw spindle from the barrel and clean with pure naphtha, Fig. 1. Then place a few drops of light oil on the threads with a toothpick as in Fig. 4. Tighten the slotted nut on the end of the barrel, Fig. 3, by stages to secure the correct adjustment. To adjust for zero setting clean the anvil and spindle by pulling a piece of soft paper between the surfaces, Fig. 5. With the anvil and spindle apart, unlock the thimble cap with a spanner wrench, Fig. 6, then tighten the cap lightly. Bring the anvil and spindle together and set the zero line on the thimble to coincide with the line on the barrel, Fig. 7. Hold the micrometer by the frame and move the spindle away from the anvil by turning the spindle only. Then, grasping the thimble, tighten the cap with the wrench as shown in Fig. 8.

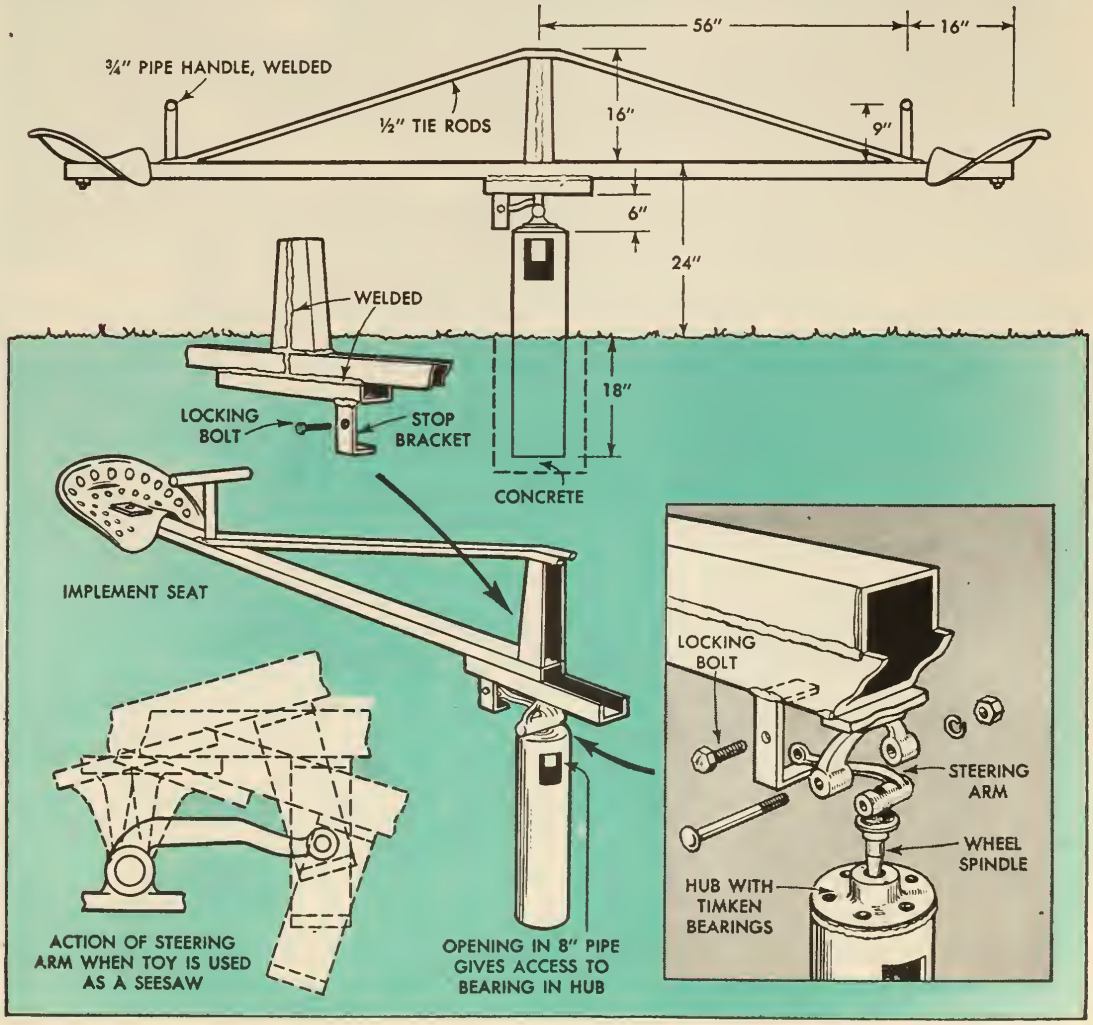
On some types of micrometers the zero setting is made by first cleaning and then bringing the spindle and anvil together, then turning a friction sleeve on the barrel until a line on the sleeve coincides with the zero line on the thimble, Fig. 9. If the micrometer is the adjustable-anvil type the zero setting can be made by loosening the binding screw in the frame next to the anvil and adjusting the anvil screw as in Fig. 10. Micrometer readings should be taken occasionally with a precision gauge block of known dimensions to determine the accuracy of the instrument.

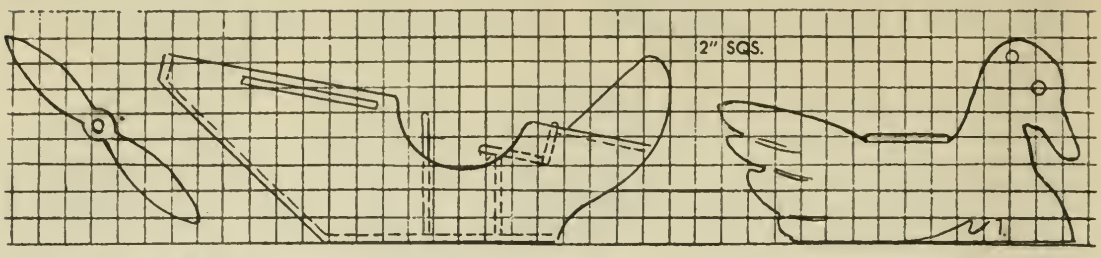
MERRY-GO-ROUND DOUBLES AS SEESAW

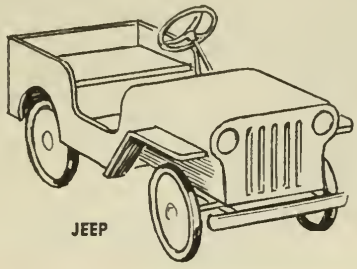
BUILT from scrap steel and auto parts, this novel back-yard toy combines the features of a seesaw with those of a merry-go-round. When used as a merry-go-round, the unit rotates on an old car-wheel spindle-and-hub assembly, plus a steering arm. The latter is used to lock the beam in a horizontal position when the toy is used as a seesaw. A U-shape bracket, through which a bolt is passed to engage the eye in the arm, limits the stroke and keeps the seats from striking the ground and jarring the riders. Note opening in side of pipe to permit access to bearing unit. To prevent its pulling out of the hub, a nut can be put on the wheel spindle. Lubricate before using.

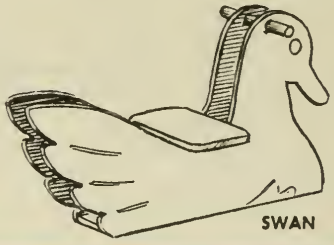


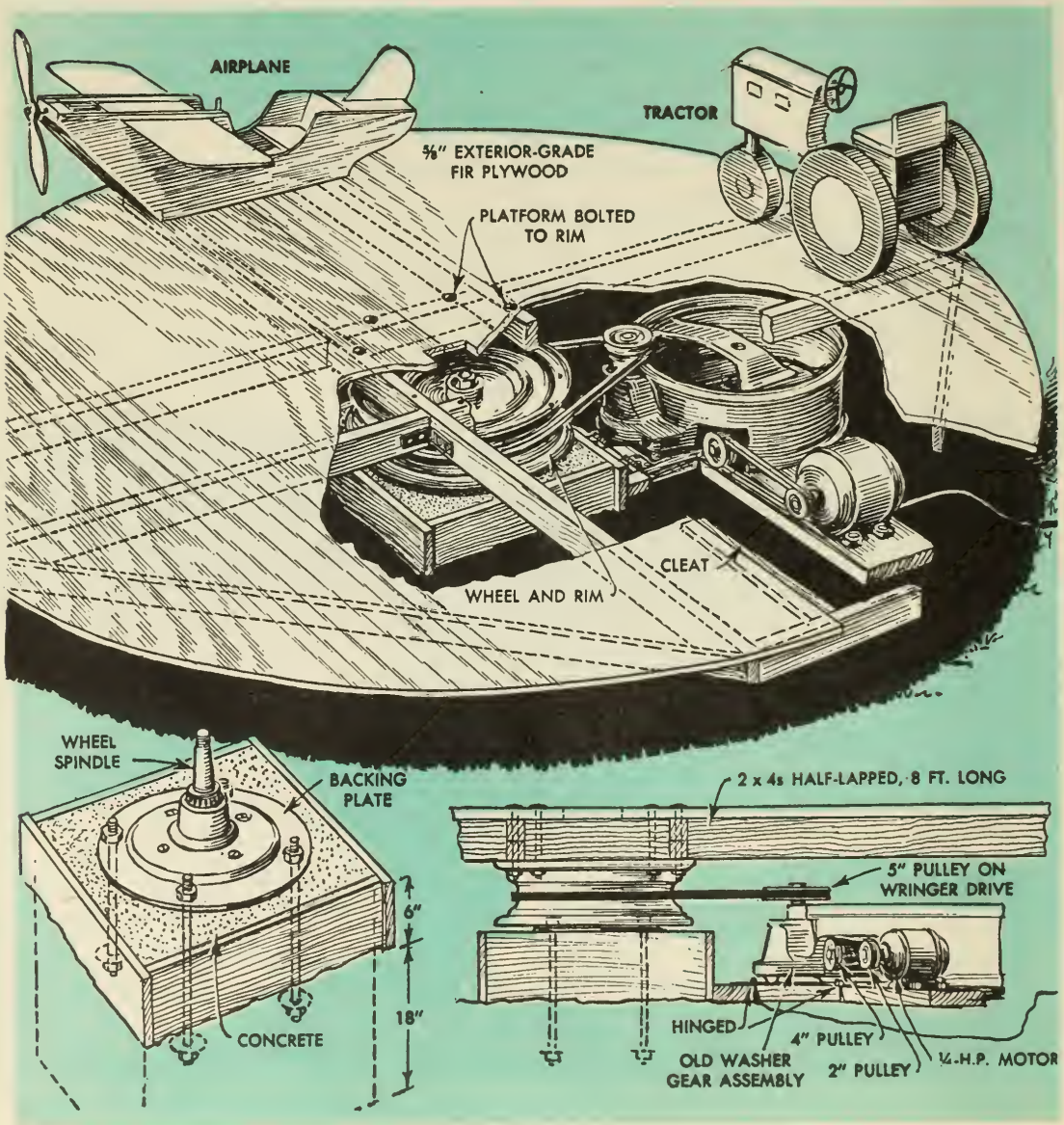
Comfortable implement seats were used on the original toy but suitable seats can be cut from wood. The supporting pipe column, which houses the hub-and-spindle assembly, is embedded in concrete




2" SQS.


JEEP


SWAN


AIRPLANE
TRACTOR
⅝" EXTERIOR-GRADE FIR PLYWOOD
PLATFORM BOLTED TO RIM
CLEAT
WHEEL AND RIM
WHEEL SPINDLE
BACKING PLATE
6"
18"
CONCRETE
2 x 4s HALF-LAPPED, 8 FT. LONG
5" PULLEY ON WRINGER DRIVE
HINGED
4" PULLEY
OLD WASHER GEAR ASSEMBLY
2" PULLEY
¼-H.P. MOTOR

BACKYARD MERRY-GO-ROUND

By Robert E. Wilson

PRESENTING your youngsters with their very own merry-go-round will make you a very popular father, and your children will be the envy of every child in the neighborhood.

Construction starts with digging a hole 20 in. square and 18 in. deep. In areas of severe cold, make the hole 30 in. deep. A form of 2 x 6s around the top of the excavation produces a concrete "pillar" that projects above ground level. Next obtain the front-wheel assembly from an auto-wrecking yard, including the spindle, bearings, backing plate and wheel. Be sure the bearings are in good condition. Drill four holes in the backing plate to accommodate four ½-in. bolts, 12 in. long. Suspend the spindle and backing plate, with the long bolts in place and nuts turned just hand-tight, over the excavation and fill it with concrete. After the concrete has seasoned several days, remove the nuts, install lock washers and tighten the nuts thoroughly so the backing plate is solid. Fit the inner bearing on the spindle, slip the brake drum in place and tighten the large retaining nut. The wheel now is bolted to the drum.

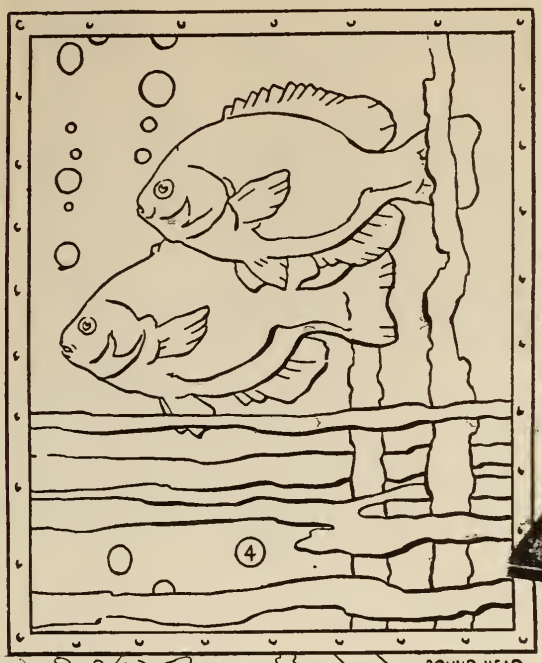
The next step is to build the 2 x 4 framework that supports the merry-go-round platform. Two pairs of 2 x 4s, 8 ft. long, are half-lapped as shown in the detail, and all joints strengthened with steel angles. Two 4 x 8-ft. sheets of ⅝-in. exterior-grade plywood are nailed to the frame and bolted to the wheel. The intersection of diagonal lines from the corners of the platform locate the center from which is scribed an 8-ft.-dia. circle. Cut an opening at the center of the platform over the wheel nut.

Power for the ride is supplied by a ¼-hp. electric motor. A 2-in. pulley on the motor is V-belted to a 4-in. pulley on the gearbox of an old washing-machine base. A 5-in. pulley is fitted on the vertical shaft of this gearbox that originally rotated the wringer rollers. From this pulley a 56-in. V-belt is fitted around the car wheel. The platform on which the gearbox is bolted is hinged so the weight of the box keeps tension on the belt. Speed of the ride is about 14 to 16 r.p.m. ★ ★ ★

BRASS TAPPING

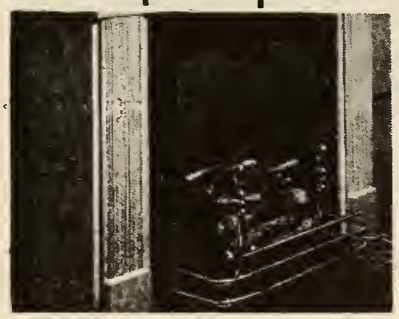
A FASCINATING hobby which has money-making possibilities as well as recreational value is brass tapping. Attractive patterns that stand out in bold relief on plaques, book ends, etc., are formed by simply punching a design through a paper pattern onto a piece of metal and tapping down the background. To start out, get a piece of 30-ga. soft sheet brass, some plywood for mounting it, a light hammer, small round-head brass nails, and a piece of ⅛-in. steel rod about 5 in. long, which is ground to a 1/32-in. point to form a tapping tool. Steel wool, lacquer, etc., are used for finishing. Fig. 6 shows how a design and a piece of sheet brass are fastened to the plywood. Nail holes are made by piercing the design sheet and metal with the tapping tool. Next, the outlines of the design, including the border, are gone over with the tapping tool as illustrated in Fig. 3, striking it firmly but not hard enough to punch holes in the metal. The taps should be so close together that the resulting impressions form a continuous line. When the transferring of the design has been completed, the paper is torn off and the background tapped down. It is best to make the taps about ¼ in. apart at first, then go over each section, always avoiding a regularity of pattern, until the surface consists of a solid mass of tool marks. After getting the "knack" of doing this work, the job can be speeded up by using two tapping tools at one time. Polishing of the brass comes next. For this you can use either No. "0" or "00" steel wool. By working back and forth in the same direction you will be able to produce a bright surface free from scratches. To preserve the shiny surface apply a coat of clear lacquer, Fig. 5, or if desired, color the background by applying bronze of the desired shade. By wiping off the high spots before the bronze has had a chance to set, it is possible to obtain some attractive effects. Still another finish consists of coloring the metal chemically. To get a black finish, dissolve a small quantity of liver of sulphur in water, and apply it to the background with a small brush. For a red-brown color use a solution of barium sulphide and water. Successful chemical coloring depends to a considerable extent on having the work perfectly clean, so it is advisable to wash the metal with gasoline or benzine. Refrain from touching the cleaned surface until the chemicals have been applied. Colors obtained by chemical action vary somewhat in intensity according to the number of applications. The final application should be followed by a coating of clear lacquer to make the finish permanent.

A simple frame which covers up the

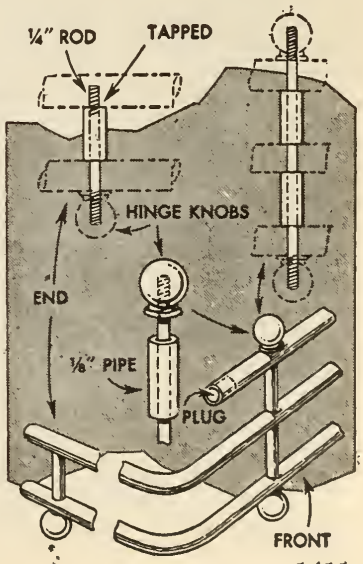


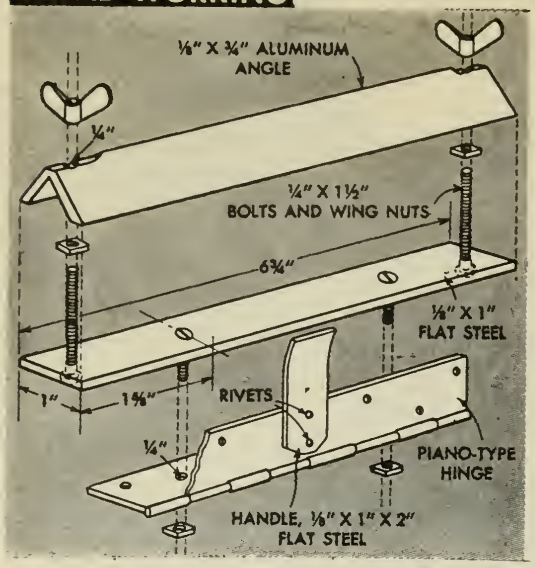
nail heads, as shown in Fig. 7, increases the attractiveness of most pieces, especially large ones like the desk-blotter pad, Figs. 1 and 2. The frame consists of two layers of hard-pressed board or veneer glued onto the plywood backing. One piece butts against the edge of the brass, and the other overlaps to cover the nail heads. By anchoring the bottom layer to the plywood with wire brads, the entire glue job can be completed with one clamping. Next comes the finishing of the wood. Sand the surface carefully to remove blemishes, surplus glue, etc., being sure not to mar the finish on the metal. Then, apply a coat of oil stain, wiping off the surplus so that the wood will not be streaked. Finish with several coats of wax. If a natural-wood finish is desired use shellac and wax.

Brass Pipe Fireplace Rails



One homeowner added a decorative touch to the hearth of his fireplace by setting these modernistic brass rails in front of the andirons. The rails, cut and bent from lengths of ½-in. brass pipe, are held together with several ball tips taken from loose-pin door hinges. Spacers of ⅛-in. brass pipe are placed between the rails and the tips, after being tapped, are screwed onto the threaded ends of ¼-in. rod. To give the appearance of rod stock, the open ends of the short top rail are plugged with pieces of brass stock, pressed in place and filed flush. All parts are buffed and lacquered.



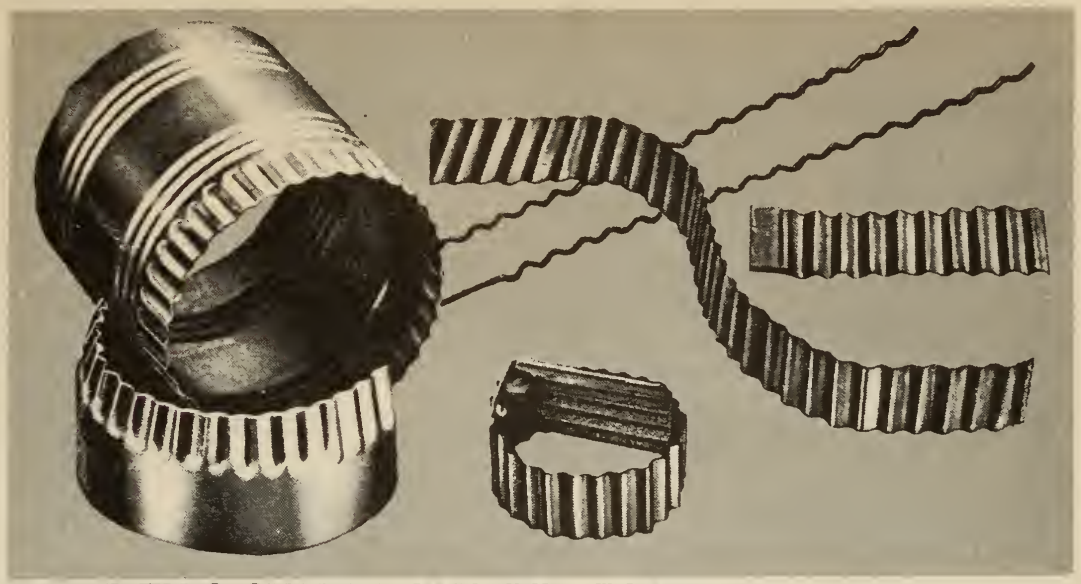


Miniature Brake for Light-Gauge Sheet Metal

ANY MODELMAKER, hobbyist or craftsman who has occasion to work with the lighter gauges of metal, will find dozens of uses for this miniature sheet-metal brake. The base of the brake is a piece of flat steel drilled for four ¼-in. screws, as shown in the detail. The two inside holes are countersunk for flat-headed machine screws which hold a piano-type hinge to the base. The two outside holes are fitted with ¼ x 1½-in.-roundheaded machine screws, held to the base with nuts. The ⅛ x ¾-in. angle used in the original was aluminum. However, steel can be used, but will be somewhat more difficult to work. A flat is filed across the heel of the angle at each end, and two ¼-in. holes are drilled to align with the end holes in the base. The legs of the angle are filed so their edges are parallel to the face of the base. Wing nuts are turned on the ¼-in. bolts that hold this angle to the base, facilitating quick adjustment. The handle for the brake is a 2-in. length of ⅛ x 1-in. flat steel, riveted to the middle of the hinge. Two holes may be drilled in the handle for attaching an extension arm. In use, the piece of sheet metal to be bent is placed on the base, the wing nuts are tightened to clamp the angle on the sheet and the hinge is swung up by means of the handle to give the desired angle of bend.

Cutting Metal in Your Jigsaw

Anyone having only an occasional job of sawing metal will find that it can be done easily on a jigsaw. All that's necessary is to convert 6-in. pieces of hacksaw blade so they can be clamped in the chucks of the jigsaw. This is done by grinding the ends of the pieces to fit the chuck. Blades most suitable for use are those made of high-speed steel, which give long service and produce clean, straight cuts. Be sure to mount the blades so that the cutting is done on the down stroke. This is necessary in order to cause the pull to come on the motor and not on the spring that raises the blade in most jigsaws. Before this method can be used, however, the speed of the jigsaw must be reduced approximately 50 percent. This is done by changing the sizes of the pulleys on both the jigsaw and the motor.

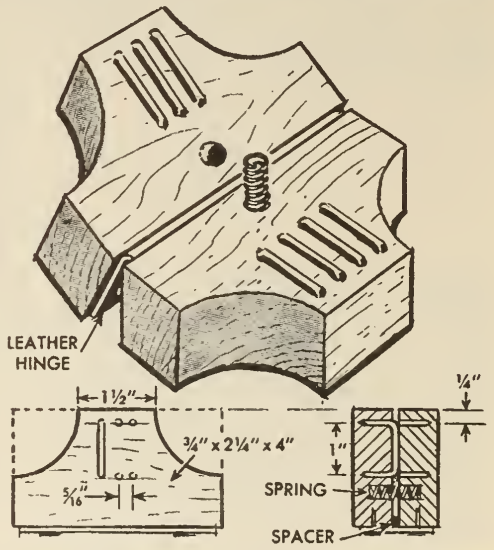


MAKE THIS SIMPLE CRIMPER FOR

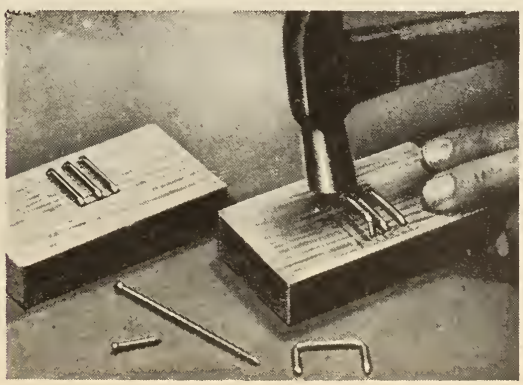
WIRE AND SHEET METAL

USING TWO SMALL BLOCKS of hardwood, 7 finishing nails, a coil spring and a piece of leather you can make a sheet-metal crimper that will turn out work such as you see in the photo above. Bandsaw the blocks to the shape detailed and hinge together with leather. Drill a hole in each to take the spring, then space and drill holes in each block to take the metal crimpers. These are made from 10d finishing nails by cutting off the heads and bending to form a staple as in the left-hand photo below and the lower right-hand detail. Drive the crimpers into the blocks, 3 in one, 4 in the other. Be careful not to bend the crimpers as you drive them home. When crimping circular work as in the lower right-hand photo use a C-clamp to apply the necessary pressure.

Walter E. Burton

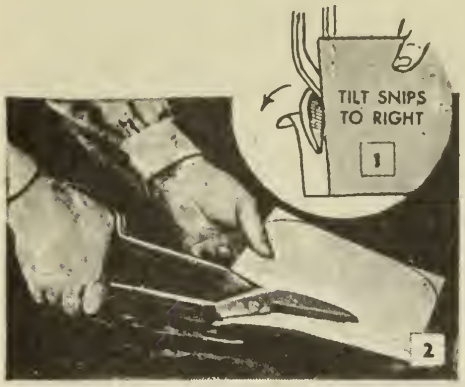


Crimpers are made from 10d finishing nails by cutting off heads and bending to the form of a staple

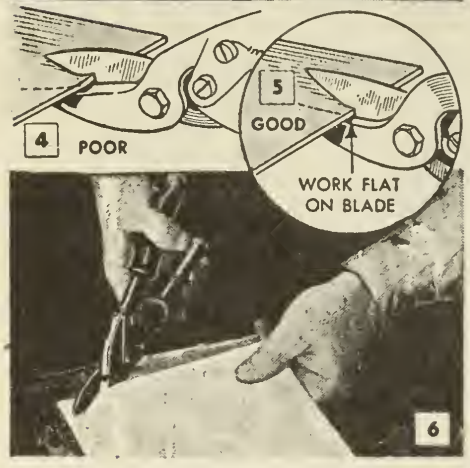


In crimping curved work such as the edges of stovepipe or furnace pipe, use a C-clamp to apply pressure

SHEET METAL CUTTING



Snips should be held square with work, except aviation type which cut best with right tilt. Below, vise mounting aids in cutting thick stock

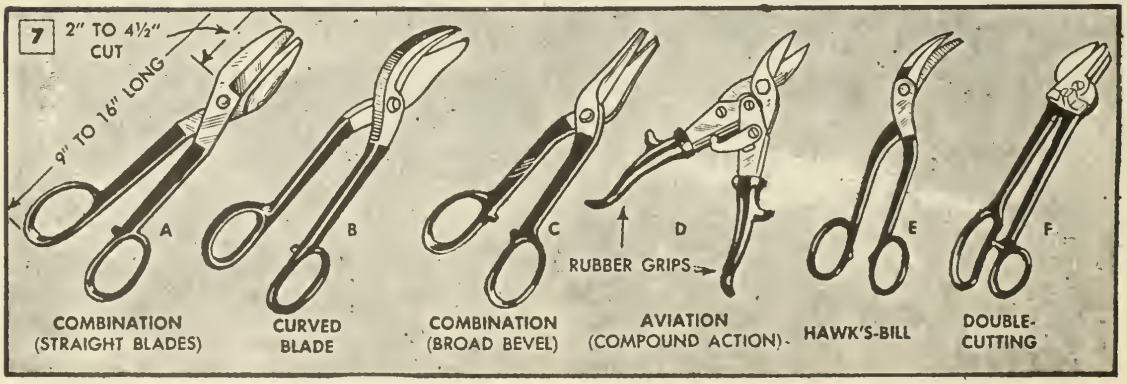


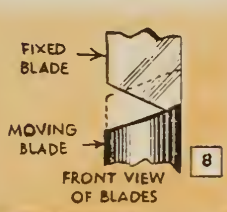
JUST AS IN woodworking, the fundamental process in working with sheet metals is cutting the stock to specified dimensions or shapes. In some instances, such as making ornamental cutouts and plain overlays, the whole job is confined to cutting operations, but more often cutting is simply a preliminary step to bending, spinning, hammering and other operations needed to complete the project.

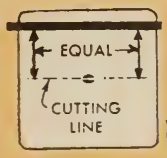
Snips are basic tools: Whatever other sheet-metal cutting tools you may have, there is always need for a pair of snips. Several popular styles are shown in Fig. 7, of which the combination snips, A and C, are favorite all-purpose tools for straight or curved cutting. Aviation-pattern snips with compound leverage are rapidly gaining in popularity. These snips make a clean cut with much less hand pressure than required for regular snips. When using snips, the blades should be held at right angles to the work, as shown in Fig. 2. If you run off the line, a slight tilt to the right, Fig. 1, will free the work pressure and allow the blades to return to the line.

Snips with a broad cutting bevel, C and D, Fig. 7, work best if tilted a little to the right throughout the cutting operation. Fig. 5 shows how the right tilt locates the lower face of the work flat on the blade. When cutting heavy materials with snips, a one-handed action with the free handle held in vise, Fig. 3, will give extra power.

Slitter and portable shear: These two are power tools and both work on the same principle, having one fixed and one moving blade, as shown in Figs. 8 and 13. The slitter is a bench tool. In a small unit, it is powered with a ¼-hp. motor which is belted to the machine with driving and driven pulleys of the same size, giving 1725 strokes per minute. It is a fast-cutting machine





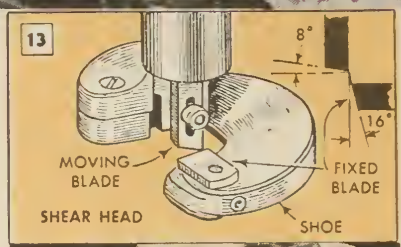


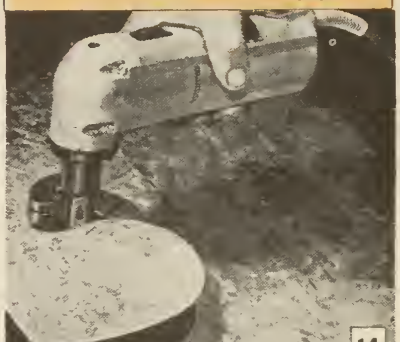
SLITTER AND PORTABLE SHEAR are fast cutters. Both work on the same principle, each having one fixed blade and one moving blade

when properly operated but requires some practice in manipulating the work and adjusting the blades. The blades will cut best if set tight on the infeed side and slightly open at outfeed side, as shown in the top view, Fig. 10. The feed rate should be smooth and uniform and the operator must guard against any tendency to lift the front edge of the work as this will invariably cause jamming.

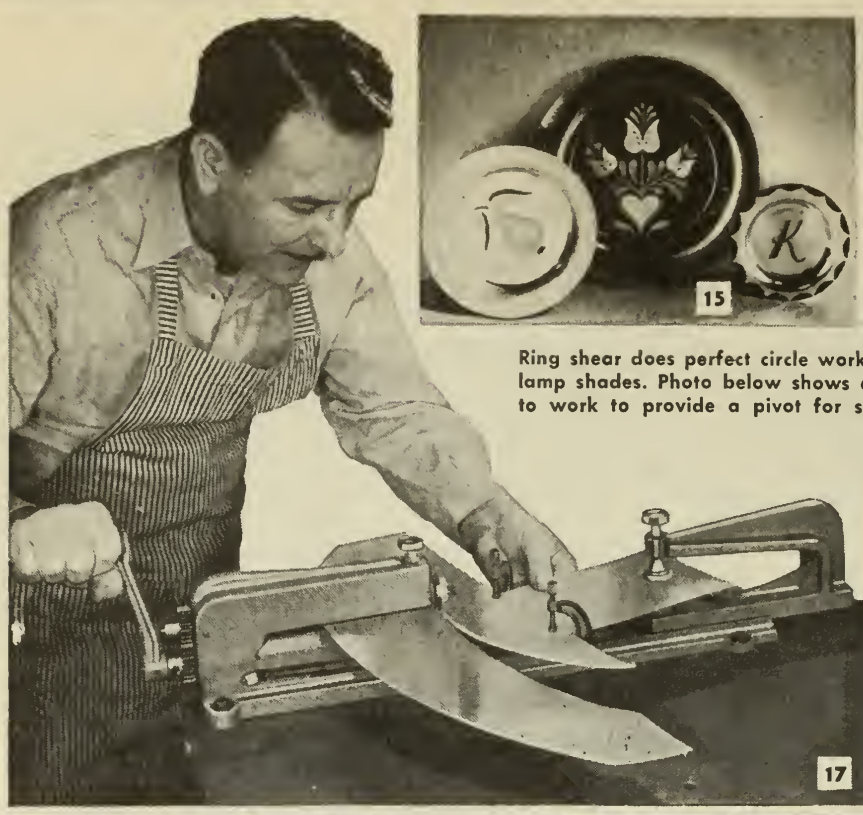
It is practical to fit a plywood table over the regular metal table and in this way gain needed work surface for large pieces. Although straight cutting with a fence is fast and accurate, it is important that the fence be set parallel with the flat side of the blades, Fig. 9. If the fence is only slightly out of line, the work may jam.

The cutting head of the portable shear is detailed in Fig. 13 and the shear is pictured in Fig. 14. This is a convenient, fast-cutting tool and the most important point in operating technique is to keep the work flat on the fixed blade. It will make inside cuts but requires a rather large hole in the stock to admit the shoe. Neither shear nor slitter is capable of

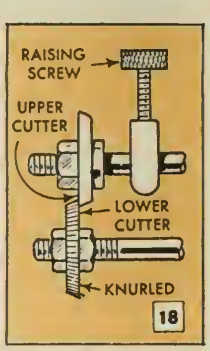




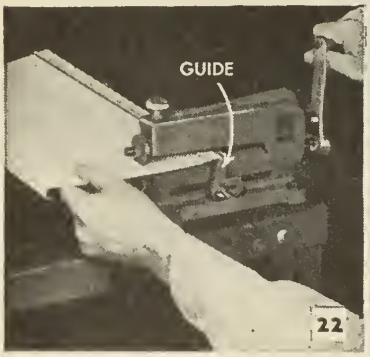
Tool Data	SNIPS	SLITTER	PORTABLE SHEAR	PORTABLE NIBBLER	HAND PUNCH	RING SHEAR	BAND SAW	JIG SAW
THICKNESS CAPACITY	21 GA. (.032")	20 GA. (.035")	18 GA. (.049")	18 GA. (.049")	20 GA. (.035")	20 GA. (.035")	ABOUT 3"	ABOUT ¼"
CUTTING SPEED per Min.	ABOUT 24"	UP TO 120"	UP TO 120"	UP TO 80"	UP TO 40 STROKES	UP TO 120"	UP TO 120"	ABOUT 30"
MINIMUM RADIUS	ABOUT ¾" (AVIATION)	ABOUT 3"	ABOUT 3"	ABOUT 2"		ABOUT ¾"	½" (⅛" BLADE)	WILL MAKE ANY CUT
KIND OF WORK	GENERAL	GOOD FOR FAST ROUGH WORK	GENERAL	STRAIGHT AND CURVES —GOOD FOR NOTCHING	HOLES AND SHORT STRAIGHT CUTS	GOOD FOR CIRCLES AND RINGS	GENERAL— FAST CUTTING	INTRICATE CUTOUTS— INSIDE CUTS



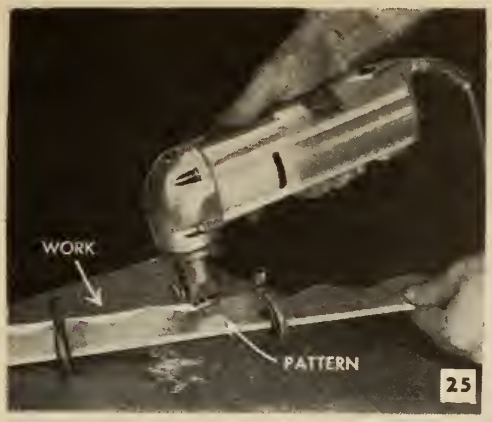
Ring shear does perfect circle work needed for plates and lamp shades. Photo below shows extension strip clamped to work to provide a pivot for swinging large segment



Circles are cut by using a pivot, which is an accessory to the shear. Cut may be started at edge of work, as in bandsawing, or top cutter can be forced through work at any point. To prevent distortion, inside cuts are made with minimum overlap of the cutters. On outside cuts, snip away the waste as cut progresses



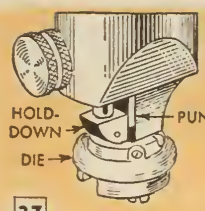
Straight cuts can be made freehand by following a pencil line, but a better way is to improvise a guide as in left-hand photo. Center photo shows how notches are cut to form box corners. Right-hand photo shows how a curved guide can be used to form a true radius. In this case, an ordinary washer served the purpose



making sharp curves. Such work must be done by making a series of tangent cuts to the dimension line and cutting away the waste.

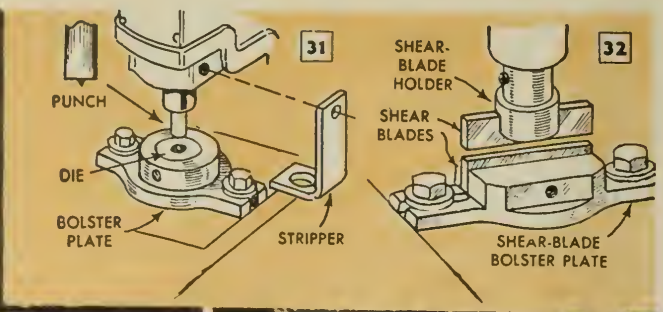
Ring shear: One of the best tools for cutting sheet metal is the ring-and-circle shear, Fig. 17. It cuts fast, is noiseless and does perfect work in cutting circles and rings needed for many metal projects. Fig. 18 shows the cutting head, consisting of two hardened steel wheels which are interchangeable. The knurled wheel will leave a slight track on the work but the interchangeable feature permits mounting this wheel to run on the waste stock.

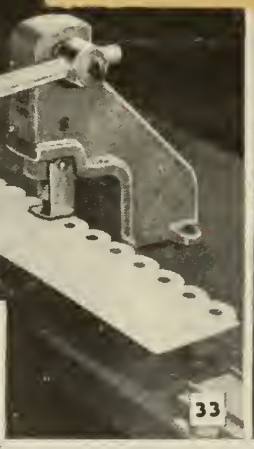
When cutting a circle, the work is clamped in the pivot jig, after which the raising screw is turned to force the cutter through the work, Fig. 19. After that, you just turn the crank. It usually is advisable to cut away the waste, or offfall, in sections, Fig. 20. Inside cuts are made in the same manner, as shown in Fig. 21. When used with the guide, Fig. 22, the ring shear



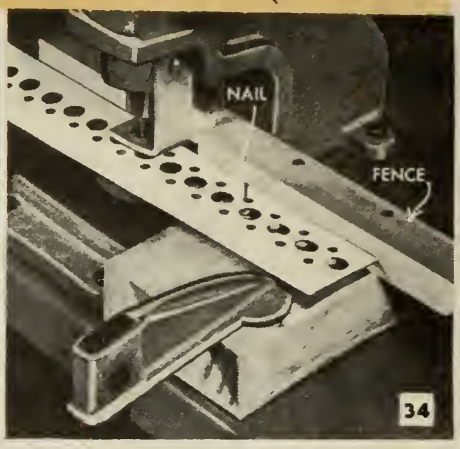
A portable nibbler can be used freehand or with a pattern as in the upper left-hand photo. Square housing permits unit to be mounted in vise as in photos

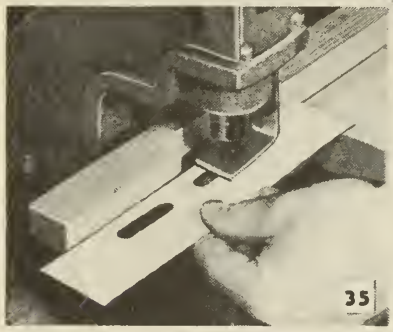
Used with a spacer board and stop on circular-saw table, the nibbler can be set up to make a variety of attractive notched borders. Work is held in place with thumbtacks





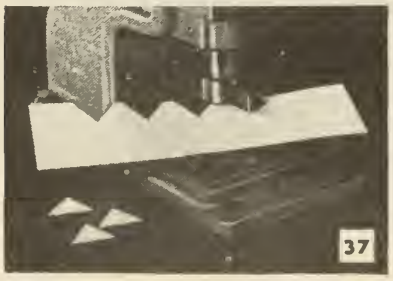
Hand-operated punch makes clean, round holes for rivets or decorative effects. Square dies are available for certain type punches, also accessory shear blades in various sizes





A hand punch does accurate slotting

Above, cutting in from edge with shear. Below, notching edge with shear blade



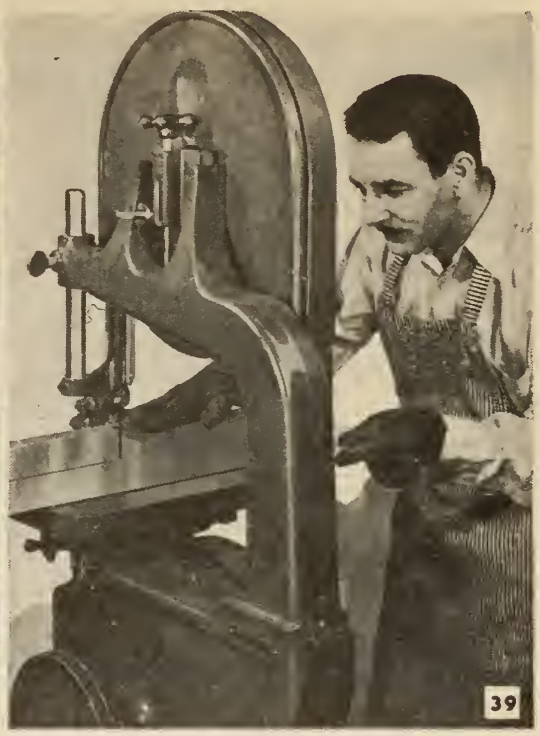
does clean, straight cutting. Fig. 23 shows a notching operation and Fig. 24 shows how a pattern can be used. In this instance a washer serves as a guide for rounding corners.

Portable nibbler: Punching tools, which include the nibbler, Fig. 26, and the hand punch, Fig. 33, work with the least distortion of the material and make the cleanest edge of all metal cutters. The portable nibbler is simply a power-operated punch. As shown in Fig. 27, the die is carried on an extension of the frame, while the punch oscillates rapidly up and down through the die. In the portable tool, the most popular type of punch is a rectangular shape measuring 1/16 x 1/4 in., with rounded edges. The slight serrations left by this type of punch are so small that the edge requires a minimum of finishing. Because of its easy portability, the nibbler is widely used in cutting large patterns and cutouts on sheet sizes which are impractical to handle on a bench machine. But it does the smaller, more intricate jobs equally well. Cutting without distortion and with no exposed parts, it will work circles down to the size of a dime. Inside cuts can be made with a 1-in. starting hole, as in Fig. 26. The use of a metal or wood pattern is practical and fast repetitive work can be done in this manner, the edge of the cutterhead riding the pattern as in Fig. 25. Many portable nibblers have a square motor housing to permit vise mounting. A good setup of this kind can be made on the circular-saw table, as shown in Fig. 28. With the work thumbtacked to a spacer board, the saw-table setup is ideal for ornamental notching, as shown in Figs. 29 and 30.

Hand-operated punch: This is one of the handiest tools in the shop and does a variety of jobs with suitable accessories. Its prime job is to punch round holes in sizes from 1/8 to 1/2 in., advancing by sixteenths. Fig. 31 shows the setup. Each punch has a tiny point at

Hole saw is useful drill-press accessory for cutting clean holes. Also is used with portable drill

Jigsaw is best for intricate cutouts in sheet metal. A 15-tooth blade does rapid work in medium stock



Bandsaw used as friction saw cuts fast and accurately on sheet metals of all kinds up to ⅛ in. thickness

the center, and this centers on punch marks made on the work. Instead of prick-punching each center mark, it is possible in repeat patterns to use a fence and guide pin, as shown in Fig. 34. After the first 4 in. of the pattern have been punched out in the usual manner, succeeding holes can be worked very rapidly. Employing a series of punched holes with the work guided along a fence, the hand punch does excellent slotting, as shown in Fig. 35. Unlike a similar operation done with drills on the drill press, the holes can be as closely spaced as desired, without distortion or runover.

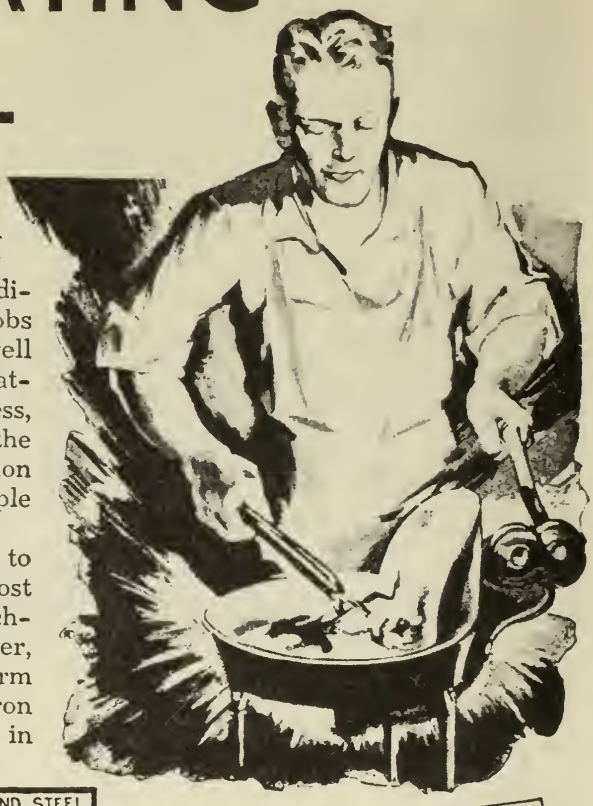
A handy accessory for the hand punch is a set of shear blades, Fig. 32. With these you can do straight-line cutting, notching and internal cutting. The shear-blade bolster plate can be used in either of two positions, as shown in Figs. 36 and 37, to suit the work.

Bandsaw and jigsaw: More familiar to the average worker, these power tools do excellent work in metal. Ordinary wood or metal-cutting bandsaw blades run at woodcutting speeds can be used to cut aluminum up to 1/16 in. thick. For fast cutting of heavier black and galvanized sheet metal up to ⅛ in. thick, the technique of friction sawing on the bandsaw is excellent. This is done with a regular metal-cutting blade, 18 teeth per inch, run at 2800 to 3000 f.p.m. Galvanized sheet stock can be cut in this way as fast as the hand can push the work, Fig. 39. For conventional bandsawing of sheet metal, the speed should be reduced to approximately 200 f.p.m., using a 24 or 32-tooth blade.

The jigsaw cuts much more slowly than the bandsaw but is the best tool for making intricate cutouts involving short-radius curves. The fastest cutting is obtained with a hardened and set metal-cutting blade with about 15 teeth per inch. For finer but slower work, 30 or 32-tooth blades should be used. Medium speed can be used for soft metals. But use only the slow speeds for sheet steel.

Other equipment: The tools described fall far short of covering the full line-up of sheet-metal cutting tools. A worth-while extra is a set of hole saws, which can be used in an electric portable drill or drill press, Fig. 38, for cutting accurate holes in sheet metal. Of the various methods, snips, ring shear and punch are the 1-2-3 selection—assuming that you already have jigsaw and bandsaw. ★ ★ ★

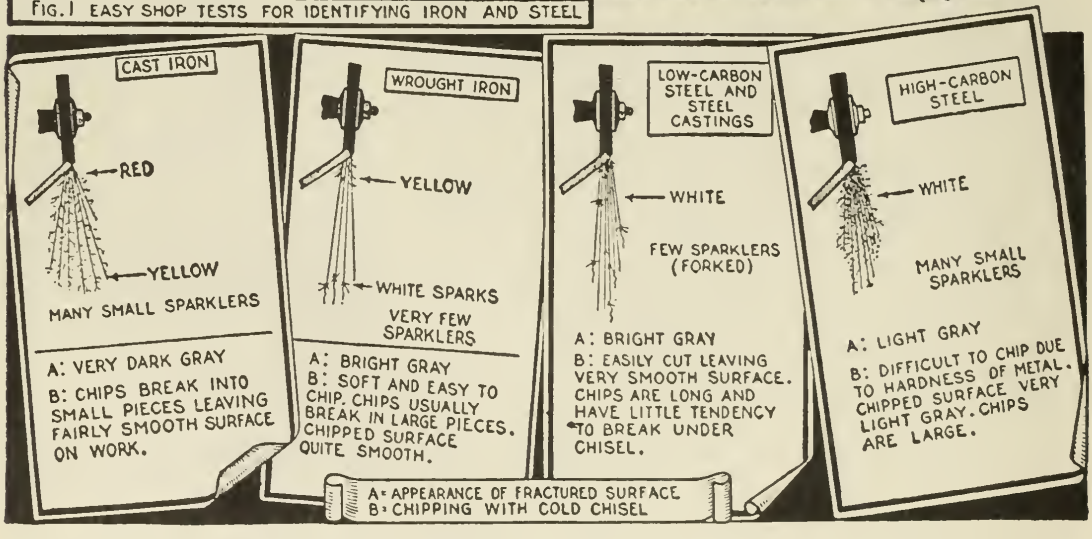
HEAT-TREATING METAL



THE natural properties of metals can be so greatly modified by simply heating and cooling under proper conditions that the success of many shop jobs is determined almost entirely by how well this part of the work is done. Heat treating of iron and steel to produce hardness, softness, springiness, toughness and the other properties required for construction purposes is not difficult if a few simple rules are followed.

Fig. 1 shows tests which may be used to classify iron and steel. The first and most conclusive test is made by lightly touching the metal to a power-driven grinder, and noting the quantity, color and form of the sparks emitted. All grades of iron and plain carbon steel have two things in

FIG. 1 EASY SHOP TESTS FOR IDENTIFYING IRON AND STEEL



common; they contain iron and carbon. Ordinary cast iron contains the most carbon, wrought iron the least, and steels intermediate amounts.

Iron castings, too hard for machining may be annealed by slowly heating them until red in a forge and cooling slowly while buried in ashes, lime or mica powder. A large box filled with well dried slaked lime or fine mica powder is handy for this purpose. If the work is well surrounded with lime or mica a day or more will be required for cooling. The slower the cooling process is, the softer and more workable will be the metal. Cast iron can be made somewhat harder and consider-

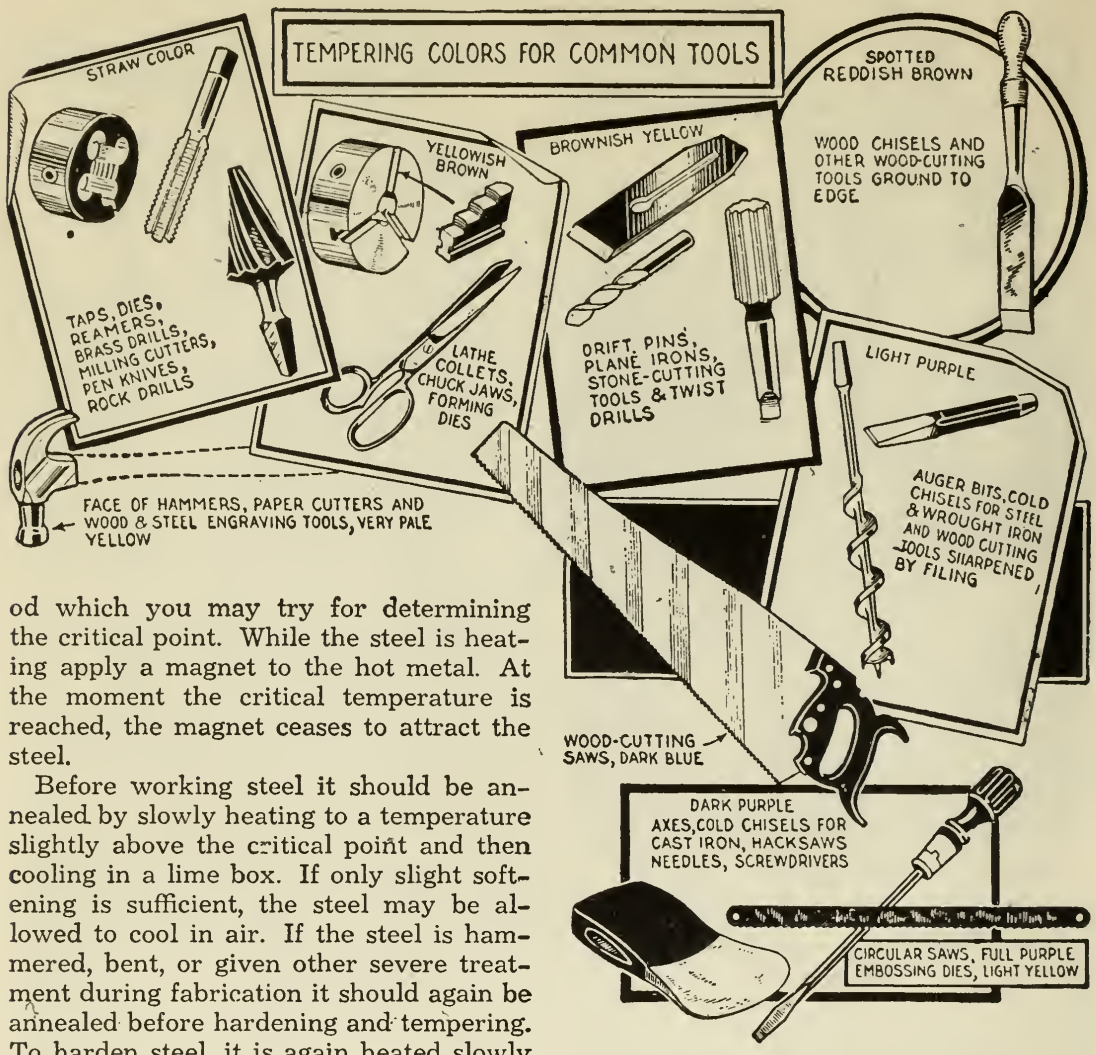
FIG. 2, COLORS PRODUCED DURING HEATING OF STEEL

Color	Temperature
Very Pale Yellow	430° F.
Light Yellow	440
Pale Straw Yellow	450
Straw Yellow	460
Deep Straw Yellow	470
Dark Yellow	480
Yellowish Brown	490
Brownish Yellow	500
Spotted Reddish Brown	510
Purplish Brown	520
Light Purple	530
Full Purple	540
Dark Purple	550
Full Blue	560
Dark Blue	570
Pale Blue	600
Bluish Green	630
Bright Red (in dark)	725
Red (in ordinary room light)	885
Red (in full daylight)	1077

Note—Colors at different temperatures depend upon the amount of light in the room

ably more resistant to wear by heating it to a bright red color and immediately plunging into, or quenching, in water. The water is best kept in a large tub beside the forge. It is important that the quantity be large so that it will not become hot too quickly. Wrought iron is much used in the forging of architectural ornaments and fixtures and it is easy to weld. After hammering and shaping wrought iron, it should be annealed by heating to a dull red color and cooling in air. Annealing relieves the strains set up in the metal by the hammer and renders it less likely to fail in use.

Different grades of steel contain varying amounts of carbon; those containing the larger amounts are called high-carbon or tool steel. Low-carbon steel is frequently termed mild steel. By observing the nature of the sparks produced when grinding, the approximate hardness of steel and hence its suitability for different purposes may be determined. Although every grade of steel has a definite temperature above which it must be heated for annealing and hardening, it is not difficult to tell when this temperature has been reached after performing the following experiment. Place a piece of steel over a lighted gas burner and watch the metal as it slowly heats. At first the metal will steadily change from its original color to a faint yellow, straw color, purple, blue, etc., until at a certain temperature it will apparently stop heating although still remaining in the fire and retaining a certain color for an appreciable time, after which it will again start to change colors and thus appear to heat faster until white heat is reached. The temperature at which the steel momentarily ceases to get hotter, indicated by the lack of color change, is the temperature at which the molecules are rearranging themselves, and at this temperature, known as the critical point, the steel is actually absorbing heat without getting hotter. There is still another meth-



od which you may try for determining the critical point. While the steel is heating apply a magnet to the hot metal. At the moment the critical temperature is reached, the magnet ceases to attract the steel.

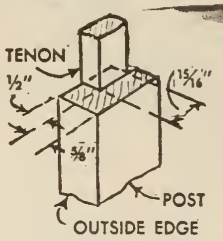
Before working steel it should be annealed by slowly heating to a temperature slightly above the critical point and then cooling in a lime box. If only slight softening is sufficient, the steel may be allowed to cool in air. If the steel is hammered, bent, or given other severe treatment during fabrication it should again be annealed before hardening and tempering. To harden steel, it is again heated slowly and evenly to a temperature just above the critical point and plunged into water. If only a part of the tool or metal is to be hardened this portion only is submerged. The steel is left in the water until it ceases to hiss, after which it may be allowed to finish cooling in the air, or in an oil bath. Hardened steel is too brittle for most purposes, therefore tools must be tempered after hardening to give them toughness. Tempering is really a process of partly softening the metal. Too much softening, however, often defeats the purpose of hardening. Steel is tempered by heating it to a low temperature and allowing it to cool in air. For most purposes a small surface of the metal may be polished until bright before heating, so that the proper temperature may be determined by the color changes during heating. A chart of colors at different temperatures is given in Fig. 2. The work may be heated in a forge over a gas flame or in sand.

MIRROR FRAME

HAND CARVING on furniture built in the home workshop gives a definite personal touch to what might ordinarily be a run-of-the-mill woodworking project. This hand-carved mirror is an excellent example of this type of work, being made in four pieces which first are carved, then assembled. It is much easier to handle and carve the individual pieces.

All stock used in the frame is 1⅛ in. The top piece is 4⅝ in. x 26 in., the sides are 1⅜ in. x 29 3/16 in. and the bottom crosspiece of the frame measures 3⅝ in. x 26 in.

Before doing any carving, the ends of side members are cut to form a tenon as indicated in the detail. The upper and lower crosspieces of the frame then are grooved to receive the tenon, so that a "half-lap tenon joint" results.



Tenons are cut on the ends of each side rail as indicated at left. They then are fitted in grooves cut in the top and bottom pieces of mirror frame to form "half-lap tenon joints"

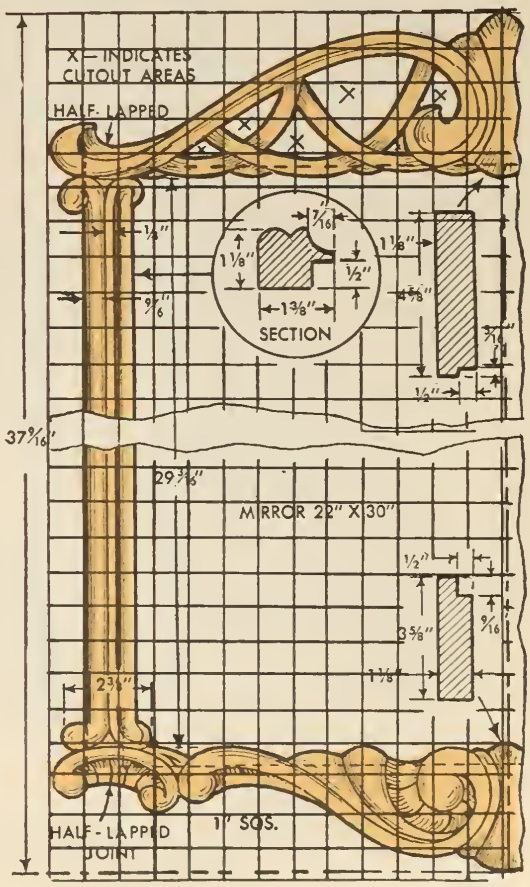
Use a Pattern

The next step is to make a pattern for the carving by drawing a copy of the squared pattern on a sheet of paper with 1-in. squares. After tracing the pattern onto the wood, cut out the areas that are marked with an "x" in the top crosspiece. A jigsaw or hand coping saw can be used for this. At least two sizes of wood chisels and a gouge are required to do the carving, although with much patience, an ordinary pocketknife and a straight wood chisel will give the same results.

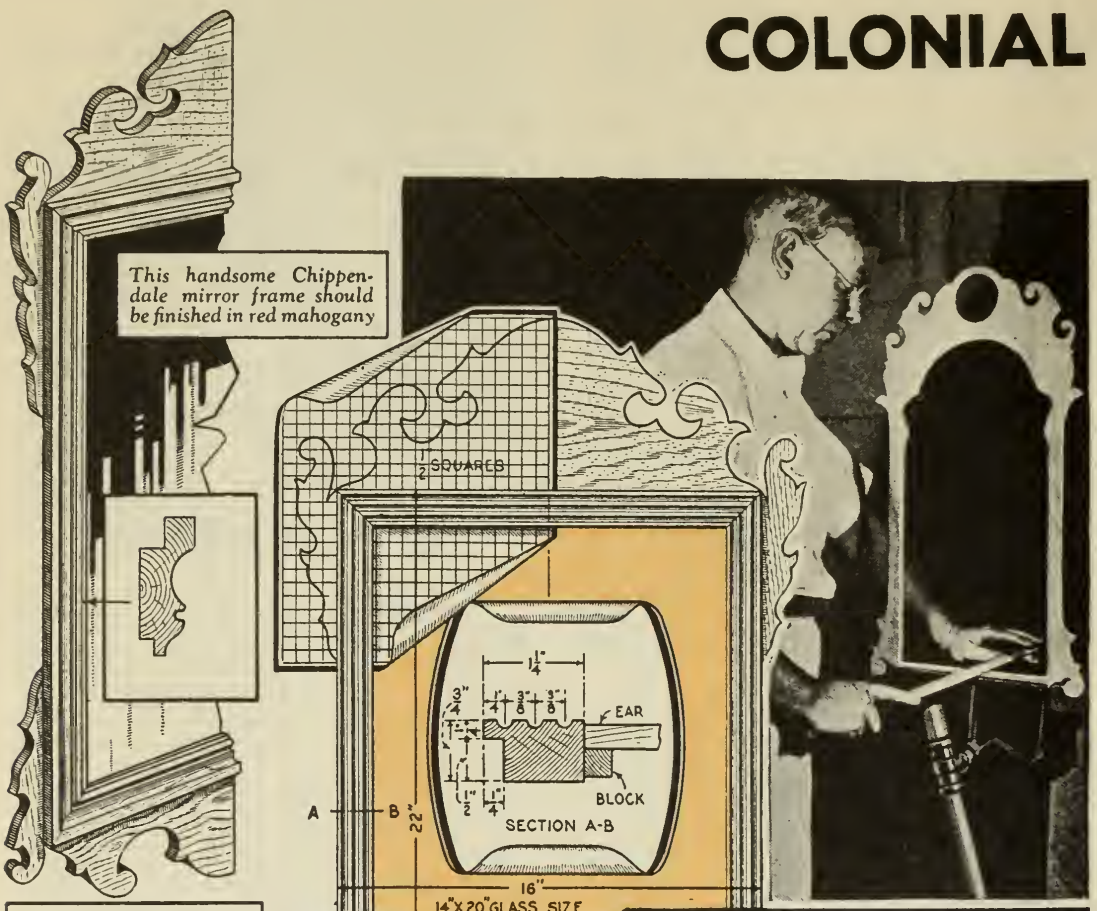
Do not worry too much about slight mistakes or irregularities in the carving. Such irregularities are what give hand carving its personality, setting it apart from machine-made work.

Finishing the Frame

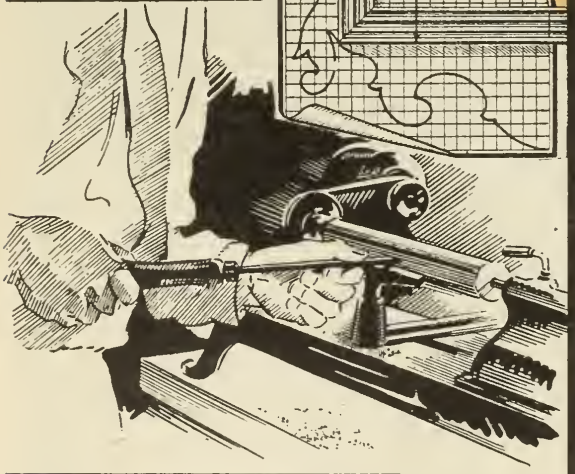
When the carving is completed, assemble the frame before applying a finish. Only glue should be used in assembly, and the frame should be clamped or held firmly until the glue is well set. The finish to be used on the frame is strictly a personal matter, which might be influenced by the type or style of furniture used in a home. An antique finish, however, is most appropriate. Wipe-on oil stains are available to produce almost any type antique finish. In some cases, it might be desirable to accentuate the carving, which can be done by wiping a light-colored pigment over the frame, allowing it to dry slightly, then wiping it off with a soft cloth. Finally, apply one or more coats of varnish.

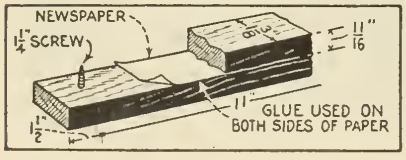


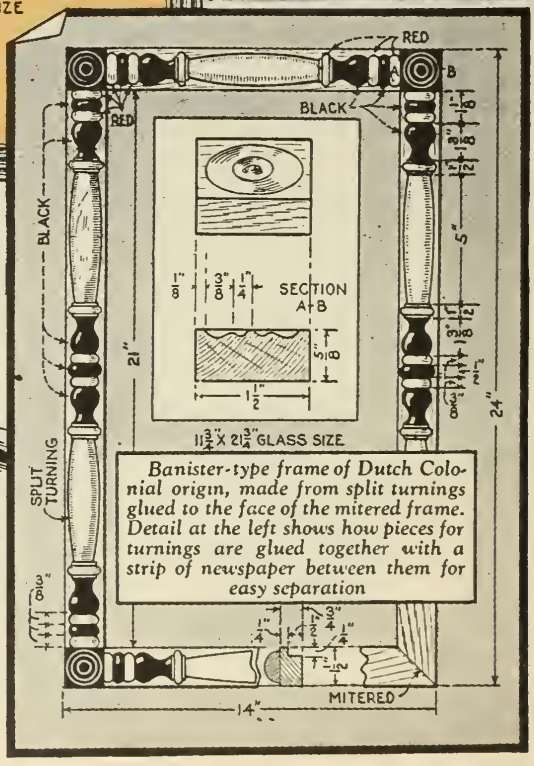
COLONIAL



The scrolled head and ears are cut from plywood and are fastened to the frame by means of glued blocks as shown in the circular detail

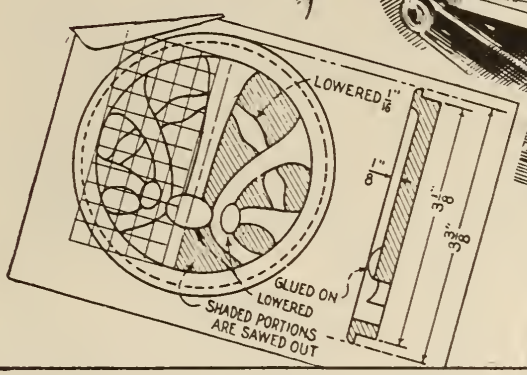


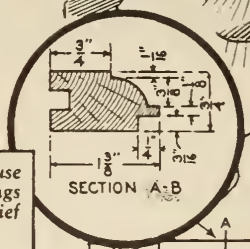




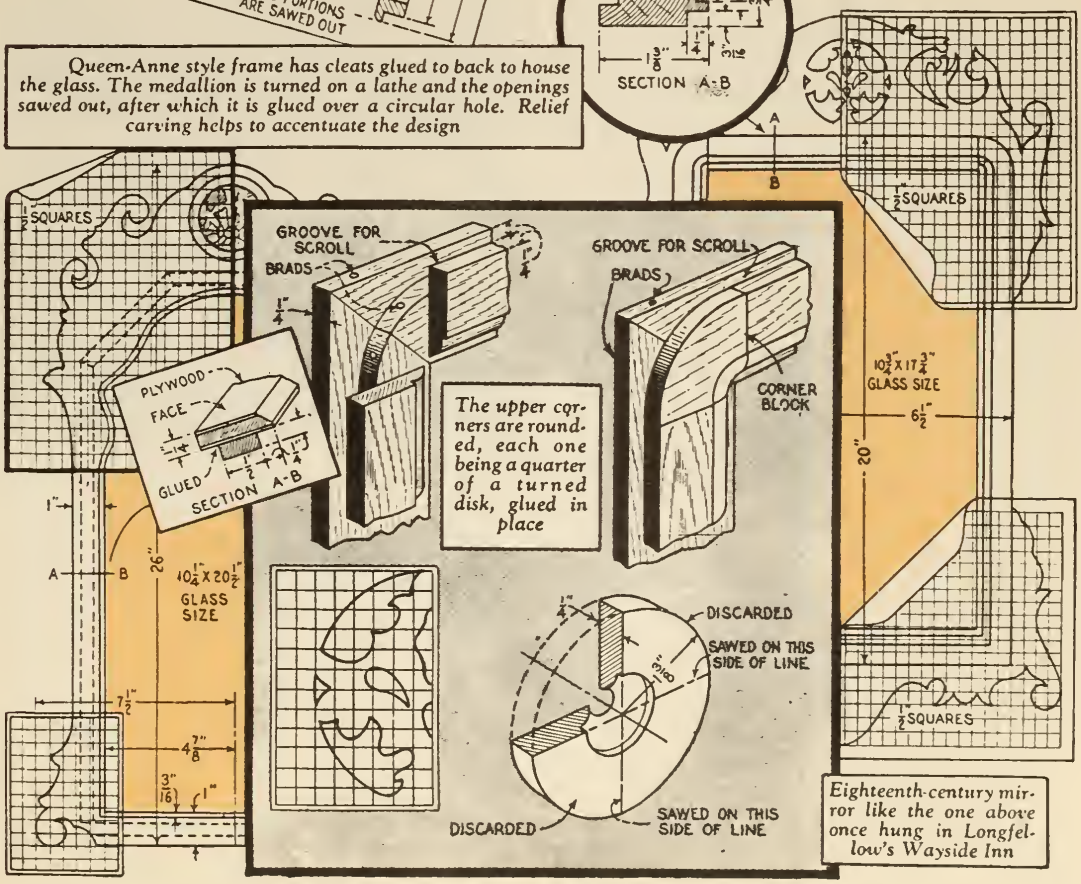
Banister-type frame of Dutch Colonial origin, made from split turnings glued to the face of the mitered frame. Detail at the left shows how pieces for turnings are glued together with a strip of newspaper between them for easy separation

MIRRORS





Queen-Anne style frame has cleats glued to back to house the glass. The medallion is turned on a lathe and the openings sawed out, after which it is glued over a circular hole. Relief carving helps to accentuate the design



Eighteenth-century mirror like the one above once hung in Longfellow's Wayside Inn

MIRROR SILVERING

The tray used for silvering can be bent from sheet metal and then set up to permit drainage, as above. The tray is made acidproof by an application of one or two coats of asphaltum paint inside and out

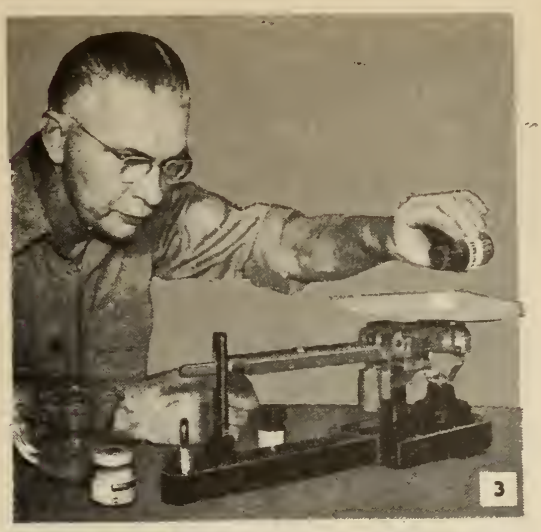
MIRROR SILVERING offers excellent opportunities for making worthwhile spare-time profits. The process is simple, requiring no training or experience, and the equipment needed involves no appreciable investment. The work can be done in a very small space, as pictured in Fig. 1, and handling the chemicals is entirely safe if you follow the normal precautions given at the end of this story.

Equipment: To begin with, you will need an acid-resistant tray large enough to accommodate the largest pane of glass that you intend to silver. The tray can be made of sheet metal by bending the edges of the sheet upward to form 1-in. sides and leaving one corner open for drainage. Or, the tray can be made from hardboard nailed to wooden rails. In either case, the tray must be acidproofed. One or two coats of asphaltum paint, Fig. 2, applied to both the inside and outside of the tray will acidproof the sheet-metal tray. Melted paraffin serves the same purpose on hardboard and wood, deep penetration being assured if the wood is heated beforehand. Four wedges of rubber or acidproofed wood also are required for leveling the glass to be silvered. Rubber doorstops provide suitable rubber wedges.

General procedure: After the silvering solutions have been prepared, the glass is cleaned thoroughly. Then the solutions are mixed together and flowed onto the glass. Safe handling of the glass is assured

if any sharp edges have been smoothed with an abrasive stick or grinding stone, as in Fig. 5. Glass used for mirrors should not have any defects and, for undistorted image reflection, plate glass should be used.

The tray is placed to drain into an acidproof container or into a suitable drain, remembering that corrosive chemicals drained into the plumbing system should be diluted with large quantities of water to prevent damage to metal pipes and fittings. The chemicals should be of the grade known as C.P.—chemically pure. Successful silvering is possible only when the prescribed chemicals are measured carefully, Fig. 3, and mixed exactly according to instructions. F[illegible] solids and liquids,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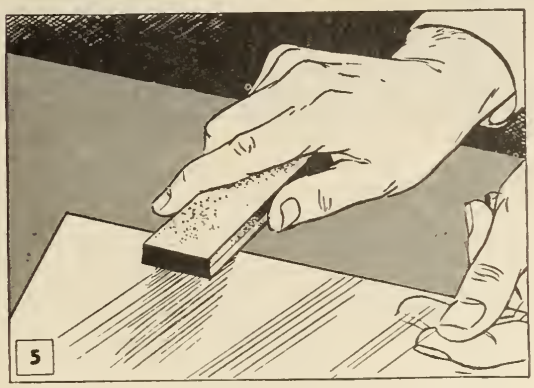
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avoirdupois and fluid ounces are used respectively. Distilled water should be used, as tap water often contains impurities that will influence silvering results. For example, the slightest trace of chlorine in the water will cause failure.

Silvering solutions: There are many formulas for the deposition of silver on glass. Three reliable ones for the layman, with complete detailed instructions on procedure, are contained in Circular No. 389 of the U.S. Bureau of Standards. This is available for a few cents from the Government Printing Office, Washington, D. C.

One of these formulas, which produces a thick and uniform coating of silver in 10 to 15 min., consists of two solutions as follows:

Solution No. 1 (Reducing Solution)

	Metric	Ounces
Distilled water	1 liter	33.81
Granulated sugar	90 g.	3.17
Nitric acid	4 ml.	.14

Boil the solution for 5 min. and allow it to cool before using. Boiling can be omitted if the solution is prepared a week or so before using it. This solution can be stored safely.

Solution No. 2 (Silver Solution)

		Metric	Ounces
A	Distilled water	300 ml.	10.14
	Silver nitrate	20 g.	.71
A^1	Distilled water	100 ml.	3.38
	Potassium hydroxide	10 g.	.35
B	Distilled water	30 ml.	1.01
	Silver nitrate	2 g.	.07

Add a solution of ammonium hydroxide (full-strength ammonia water) in minute quantities to solution A. This causes a precipitate to form which must be cleared up by continuing to add the ammonia, drop by drop. Ordinary household ammonia cannot be used for this purpose. Do not add more than the final drop needed to just clear the solution. Shake or stir the solution between additions of ammonia to get its full effect. Then, when the solution has been cleared, you add solution A^1, which again causes a heavy precipitate to form. This also must be redissolved by adding ammonia cautiously as before. The correct addition of ammonium hydroxide is highly important. A slight excess of this prevents deposition of silver; too small an amount results in precipitated silver, which should be removed by filtering.

After clearing the solution the second time, add as much of solution B as necessary to produce a slight but permanent darkening. If the correct amount of ammonium hydroxide has been added, very little of solution B is needed. If an excess of ammonium hydroxide was added, a great deal of solution B—perhaps even an additional amount—is needed.

Solution No. 2 is enough to silver approximately 125 sq. in. of glass surface. This solution should be made up only for a day's requirements, and should not be stored overnight. Solutions containing silver nitrate and ammonia produce explosive compounds if left standing.

Cleaning procedure: The glass surface to be silvered must be cleaned thoroughly as follows: Mount it on rubber wedges in the drain tray and rub washing soda or nonabrasive cleaning powder on the glass with a clean, moistened cloth or wad of cotton as in Fig. 4. The glass should not be touched

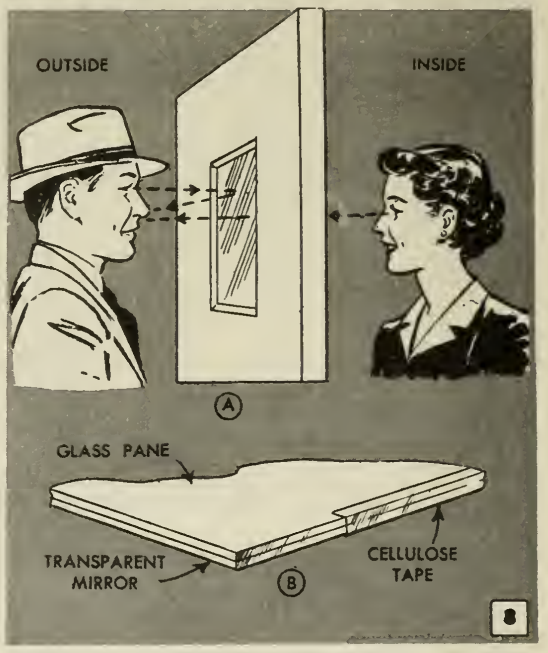
with the fingers unless rubber gloves are worn. After rinsing with water, swab the glass with alcohol or carbon tetrachloride; then rinse and swab again with nitric acid diluted in 3 parts of distilled water. Swab with a cotton wad on a length of ¼-in. dowel so that moderate pressure can be applied. After washing away the nitric acid with distilled water, allow water to stand on the glass until silvering. A film of water from ⅛ to 3/16-in. thick will cling to the glass without running off if the glass is leveled by means of wedges, as in Fig. 6.

Removal of old silver: Use varnish remover to soften the protective coating of paint or varnish over old silvering. Wipe the softened varnish off with a rag or paper towel. Don't use steel wool or any scraper that is likely to scratch the glass. Particles of sand in a rag can scratch glass. Remove old silvering with a nitric-acid solution of the same proportions as that used for cleaning. Then rinse the glass and put it through the cleaning process.

Silvering operation: Solutions Nos. 1 and 2 now are mixed in the proportions of one volume of No. 1 to four volumes of No. 2. You mix them just before flowing the resulting solution onto the glass. The deposition of silver starts immediately after mixing. Drain off water standing on the glass, then pour the working silver solution on the center so that it spreads to all edges, as thick a film as can be held without running off. After 15 min., drain off the spent solution. If a thicker coating of silver is required because of thin spots, a second and even third deposition is made, each following the previous one immediately. After silvering, the glass is rinsed with cold water and set aside to dry.

Protective coating: When dry, the silvered surface is given a coat of protective varnish or paint, carefully applied with a spray gun or with a camel's-hair brush, Fig. 7. Drying should not be forced by heat.

Transparent mirrors: Mirrors that are practically transparent when viewed from one side have considerable utility as door



lookouts, Fig. 8. They are made by depositing less silver on the glass—just enough so you can barely read newspaper print through the glass. Such mirrors are transparent from the side having the least illumination. The protective coating in this case should be transparent varnish. To shield the varnished back against scratches an extra pane of glass is used, detail B.

Handling chemicals safely: Be sure to keep silver nitrate, nitric acid and solutions of these and other corrosive chemicals well away from the skin, clothes and other materials, to prevent burns and deterioration. Wear rubber gloves and goggles for safety. If acid should contact skin, wash away all traces of it under running water. Mix acids and water in glass or earthenware containers, since these are not attacked by most acids. When diluting an acid in water, never add water to the acid, but always add the acid slowly to the water while stirring the latter. Also provide adequate ventilation to carry the fumes outside. ★ ★ ★

YOUR OWN CONCRETE MIXER

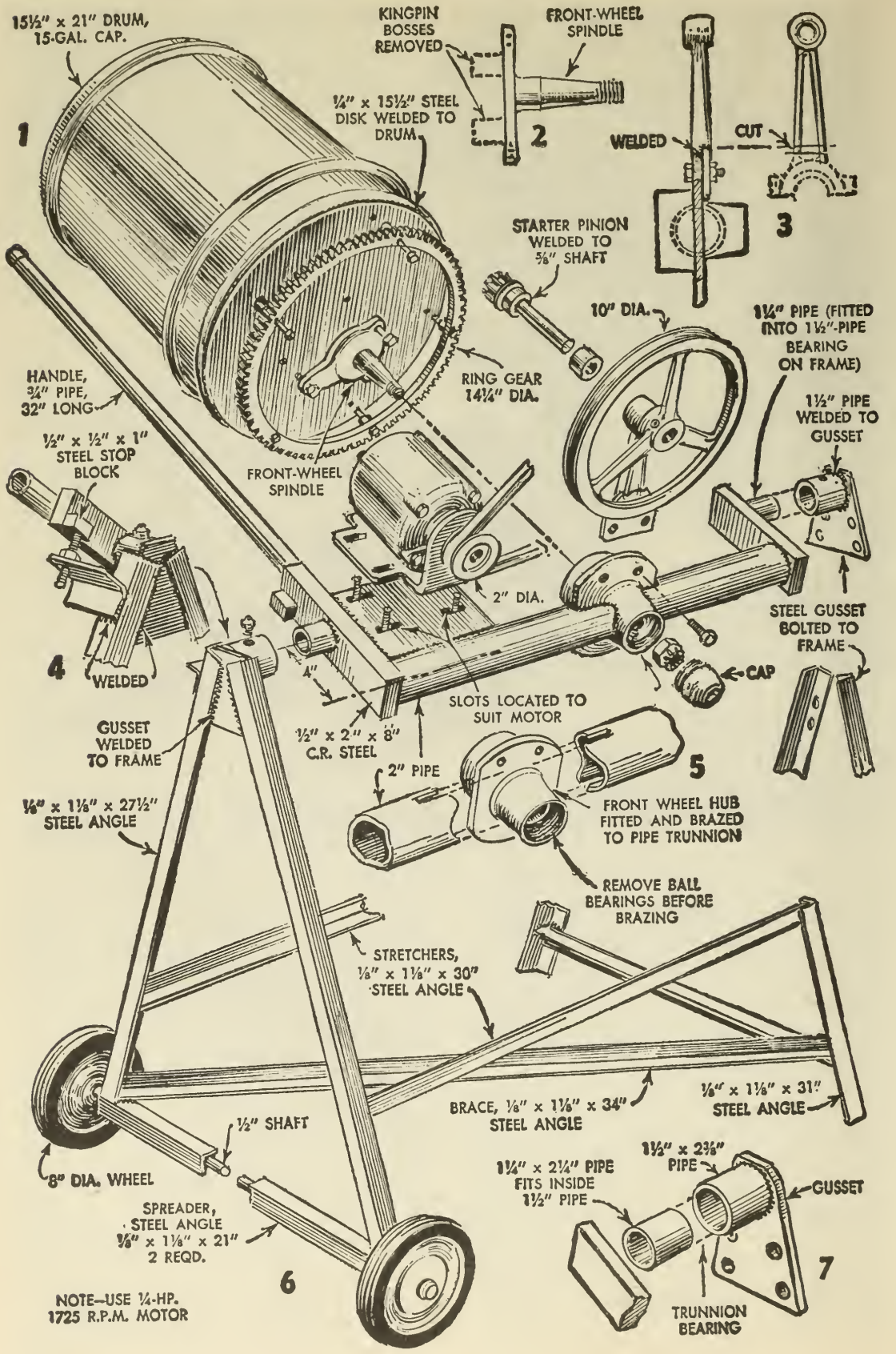
By F. C. Presotto

THAT WEEK-END JOB of mixing concrete for a planter, patio, section of walk or terrace steps won't look half as tiring if you have this mixer to take over the hard work. It's of a size to keep you busy, but not too busy, shoveling gravel, sand and cement and wheeling the concrete mix to the forms.

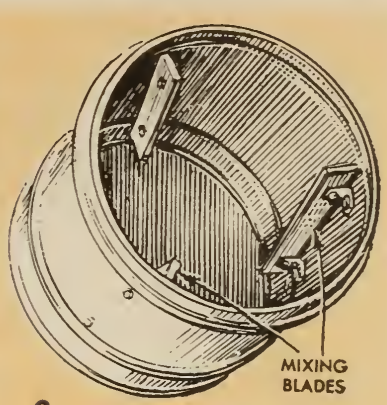
Thorough mixing—that's the secret of good, sound concrete work. This little mixer does everything the big ones do, but does it at a one-man rate. Its main parts are a 15-gal. steel drum, and auto starter pinion and ring gear, a front wheel hub and spindle, an auto-engine connecting rod and a ¼-hp. motor. Figs. 1 through 5 show how these parts are altered and assembled on a trunnion, which is mounted on a wheeled carriage, or cart, for easy portability.

With the necessary parts at hand, first cut and weld a steel disk to the bottom of the drum. Then spot and drill holes for the bolts holding the ring gear, Fig. 1. Note that spacers are indicated on the ring-gear bolts. Ordinarily, these should be about ⅜ to ½ in. long to allow clearance for the pinion. Next, the kingpin bosses are cut from the auto-wheel spindle. Fig. 2, and the altered spindle is bolted to the bottom of the drum.

Note in Fig. 3 how the connecting rod is cut and then shouldered by grinding or filing down to the web. A ¼-in. steel plate is welded to the shouldered portion. In the assembly, Fig. 5, it will be noted that this plate is bolted to the flange of the wheel hub and that the bearing at the upper end of the rod, originally the wrist-pin bearing, forms a bearing for the


15½" x 21" DRUM, 15-GAL. CAP.
1
KINGPIN BOSSES REMOVED
FRONT-WHEEL SPINDLE
¼" x 15½" STEEL DISK WELDED TO DRUM
2
WELDED
CUT
3
STARTER PINION WELDED TO ⅝" SHAFT
10" DIA.
1¼" PIPE (FITTED INTO 1½"-PIPE BEARING ON FRAME)
1½" PIPE WELDED TO GUSSET
HANDLE, ¾" PIPE, 32" LONG
RING GEAR 14¼" DIA.
½" x ½" x 1" STEEL STOP BLOCK
FRONT-WHEEL SPINDLE
2" DIA.
STEEL GUSSET BOLTED TO FRAME
4
WELDED
CAP
4"
SLOTS LOCATED TO SUIT MOTOR
½" x 2" x 8" C.R. STEEL
GUSSET WELDED TO FRAME
2" PIPE
5
FRONT WHEEL HUB FITTED AND BRAZED TO PIPE TRUNNION
⅛" x 1⅛" x 27½" STEEL ANGLE
REMOVE BALL BEARINGS BEFORE BRAZING
STRETCHERS, ⅛" x 1⅛" x 30" STEEL ANGLE
BRACE, ⅛" x 1⅛" x 34" STEEL ANGLE
⅛" x 1⅛" x 31" STEEL ANGLE
½" SHAFT
8" DIA. WHEEL
SPREADER, STEEL ANGLE ⅛" x 1⅛" x 21" 2 REQD.
6
NOTE—USE ¼-HP. 1725 R.P.M. MOTOR
1¼" x 2¼" PIPE FITS INSIDE 1½" PIPE
1½" x 2⅜" PIPE
GUSSET
7
TRUNNION BEARING

8

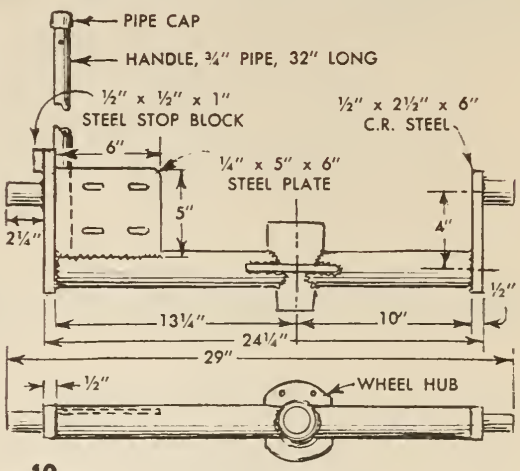


9 INSIDE VIEW OF DRUM

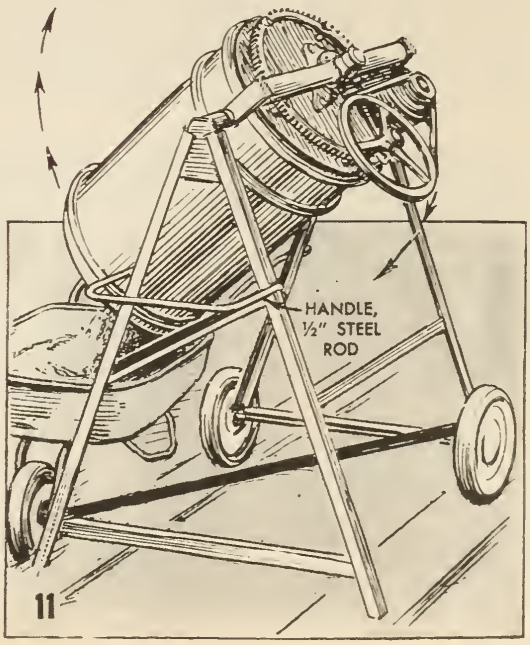
pinion shaft. Refer to Fig. 10 for dimensions of the trunnion, handle and stop. The latter also is shown in Fig. 4. Cut the ends of the two lengths of pipe which form the trunnion shaft to fit the contour of the wheel hub, then slot the ends to fit around the hub flange as in Fig. 5. Obtain a close fit of these parts. Join by brazing. Weld the other parts to form cranks with 4-in. offsets. Weld the handle, stop block and the motor mounting plate in place.

Before assembling the drum and the drive mechanism, cut parts and assemble the cart, joining all parts by welding as in Fig. 6. Note that the trunnion swings on bearings made by telescoping two short pieces of pipe, 1¼-in. pipe into 1½-in. pipe as in Fig. 7. The larger half of the bearing is welded to an A-shaped steel gusset, one of which is welded to the A-frame of the cart. The bearing assembly on the opposite end of the trunnion must be bolted to the A-frame. Now, set the trunnion in place, bolt the bearing assembly to the A-frame of the cart, then weld a steel angle bracket to the opposite A-frame, locating it so that the end will clear the arm of the trunnion. Drill and tap the bracket to take a short length of threaded rod. Turn the length of rod into the tapped hole, run down a nut and you have a simple adjustable stop as in Fig. 4. Set the drum assembly in position, bolt the motor in place and then assemble the parts of the driving pinion, Figs. 1 and 8.

As the final steps, fit three mixing blades inside the drum, spacing them equidistantly and attaching them with steel angles and bolts, Fig. 9. Bend a ½-in. steel rod to a U-shape and weld to the A-frame as in Fig. 11 to form a handle for wheeling the cart. When in use the mixer should be thoroughly flushed with water after every batch, otherwise a residue of hardened material will build up on the inside of the drum. ★ ★ ★



10 TRUNNION ASSEMBLY (SEE FIG. 5)



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Whether you use it to hide a joint, to create a high or low-room effect or to take away that homemade look from your shop-built furniture projects, you'll find that

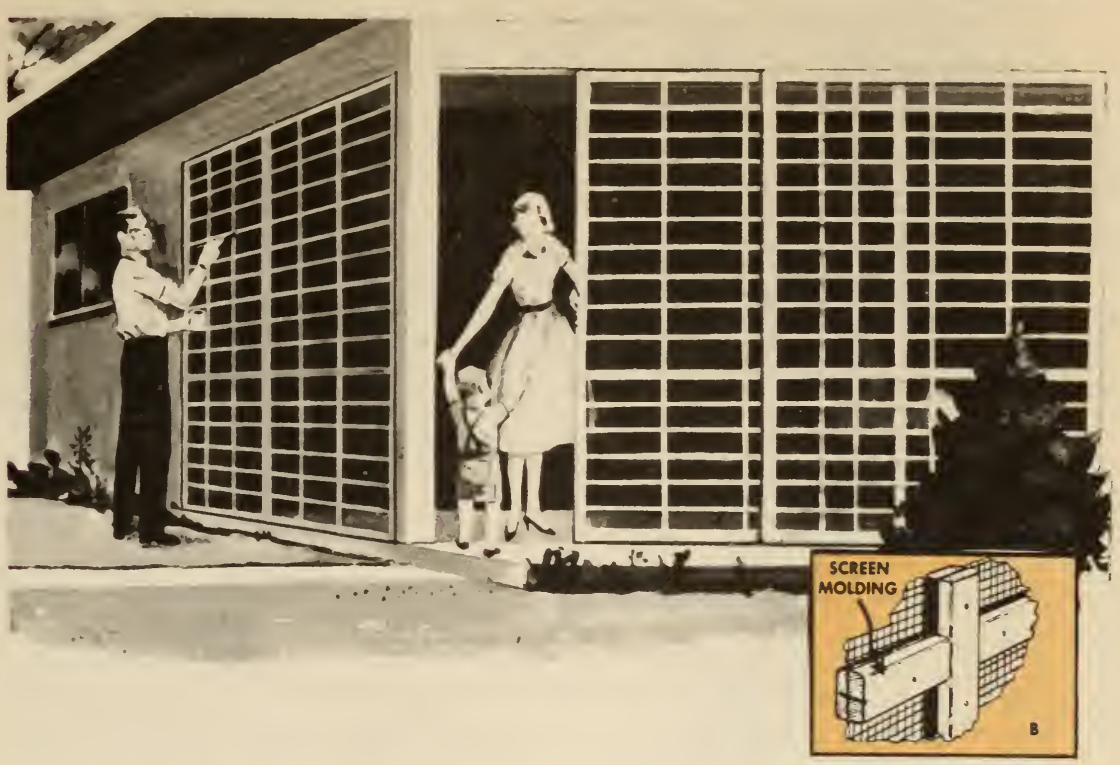
MOLDING MAKES THE

AS MOST EVERYONE knows, a piece of molding is just the thing for covering up an ill-fitting joint. But that's far from all it can do. Each of the hundreds of different moldings that you will find in a well-stocked lumberyard was made to do a certain job. Add a touch of ingenuity and they will do more in the way of smart cabinet-door handles, facings for plywood edges, unique picture frames and so on. In addition, moldings can be used to add height, or lowness, to separate surface planes and to create textural effects. The effect—the décor—can be either traditional or contemporary.

Shapes Standardized

Most moldings are of softwood, with the lion's share coming from pines, firs, redwoods, spruces and cedars of the Western states. In the past, many mills made fairly similar "standard" patterns, but pieces

High-level look to modern rooms with low ceilings is created by applying nested rectangles of half-round molding to the ceiling. This stunt also affords chance to put more color into a ceiling without losing the unity that the plane provides a room

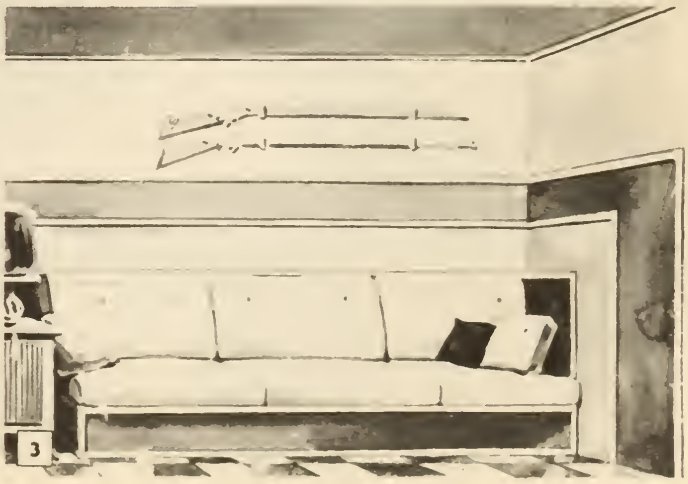


DIFFERENCE

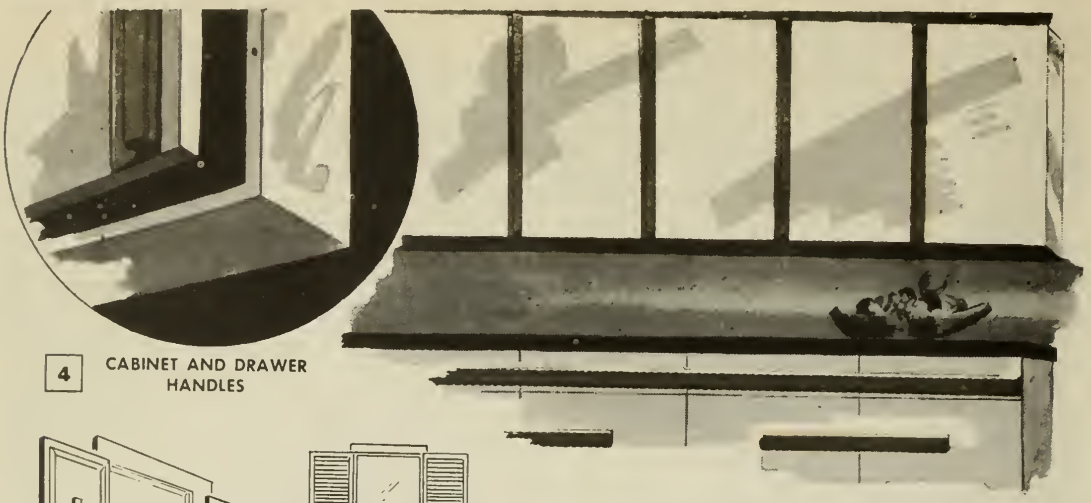
By Tom Riley

seldom matched exactly unless they all came from the same stack. However, in 1957 the Western Pine and West Coast Lumberman's associations joined in establishing exact sizes and shapes for more than 500 standard patterns of molding, and the mills in the West and many others have replaced their molding knives to conform with those standards. Today, you'll find that most of the moldings obtained at different times or places will match.

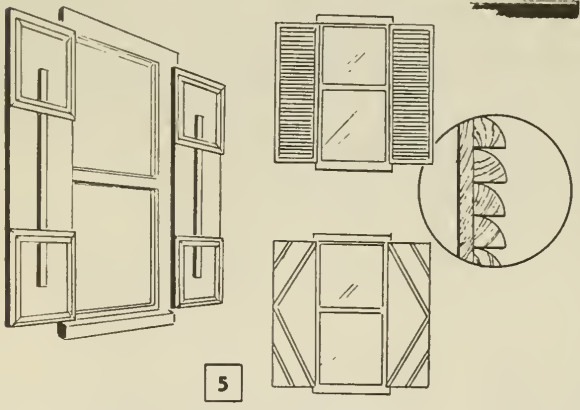
The names given to some standard moldings are confusing. Crown, bed and cove moldings, Fig. 8, are similar, mechanically, and in the larger sizes, are used primarily for wall-to-ceiling joints. Bases are baseboards. Base shoes are designed to cover the joint between the baseboard and the floor. They come in varied patterns and can replace ordinary quarter-round for many other usages. Picture moldings are not for picture frames (though many will



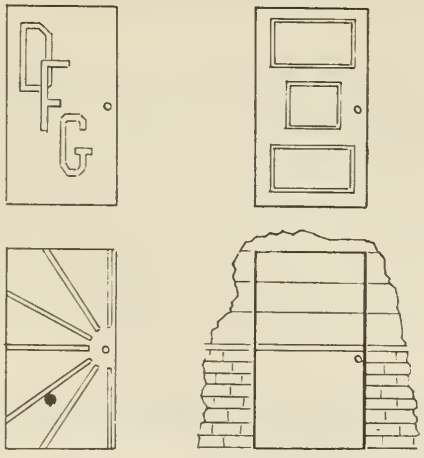
Long, low lines are stressed in this interesting use of molding which emphasizes length and lowness to a built-in sofa. Note, too, how molding ties planes and surfaces together. Permits areas between molding to be decorated in harmonizing colors



4 CABINET AND DRAWER HANDLES

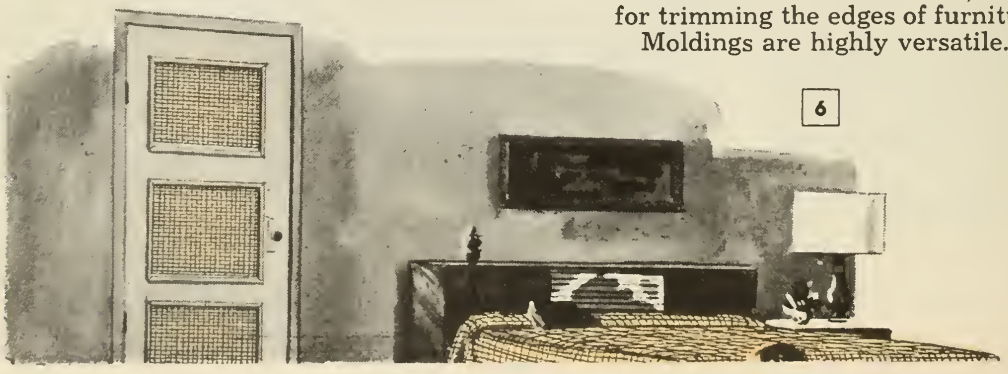


5 DOOR AND SHUTTER TREATMENT



serve nicely) but are the horizontal strips near the ceiling for hanging pictures. Casings are the trims for doors and windows. Sometimes base molding is used for a casing and vice versa. Mullion casing was originally made to cover the narrow space between two side-by-side windows but today is used for battens, wainscoting trim and the like. Screen stock, Fig. 12, balusters and others are quite similar to ordinary-dimension lumber, the difference being a better grade of wood and more careful sizing. Stops are the strips in doors and windows for stopping or guiding same, drip caps go over doors and windows; stools are the flat part of a window sill on the inside, Fig. 13. All of these and many more standard moldings are available today in a great variety of patterns and sizes. You'll find that most flat moldings are hollow-backed, Fig. 7. The hollow lets them fit snugly against a plaster wall instead of riding on top of any small surface irregularities. Two special groups of moldings also have many uses around the home. One is picture-frame stock, more expensive than standard molding but available in unique shapes and often prefinished. The other is machine-carved hardwood trim, designed for trimming the edges of furniture.

Moldings are highly versatile. Fig 1



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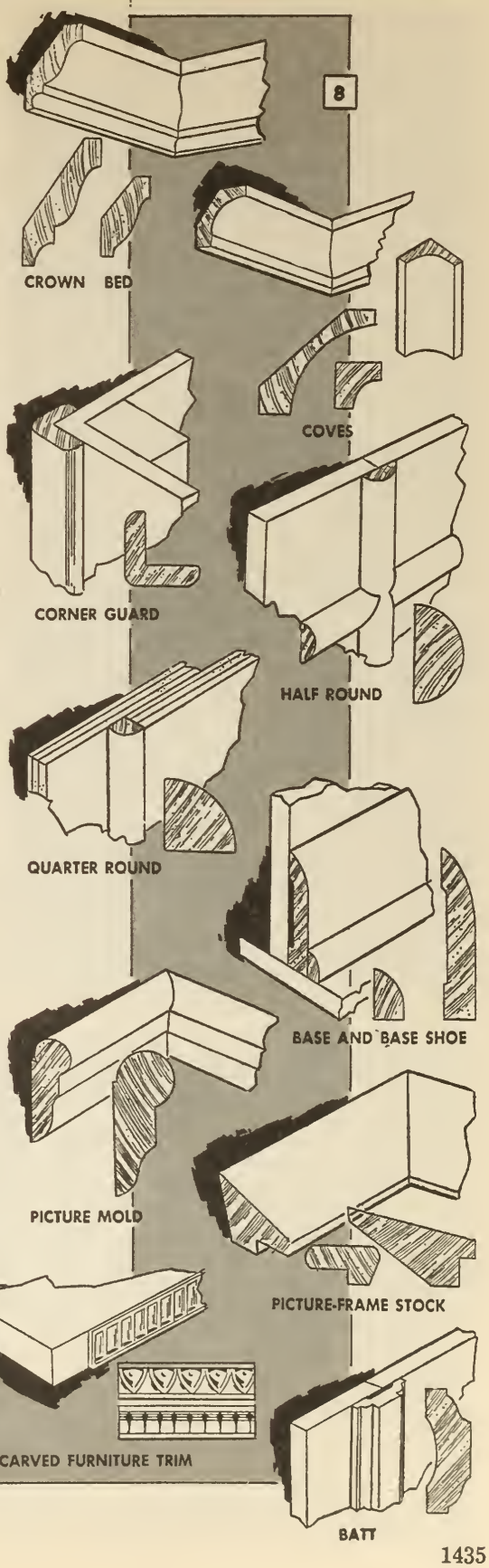
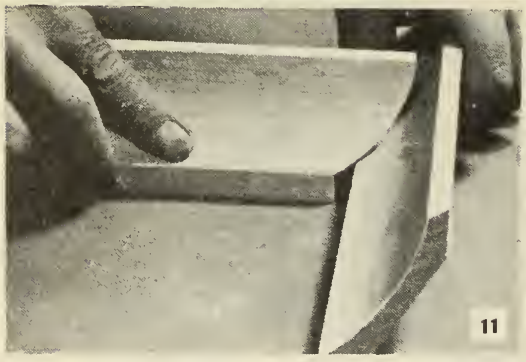
shows how a board-and-batten treatment of common screen-stock will relieve the plain, uninteresting look of a one-piece overhead garage door. When the same treatment is carried out on a board-and-batten exterior, the door becomes less conspicuous by blending in with the rest of the house. An overlay of molding in the design of a gate as shown in detail A, Fig. 1, adds the feeling of lowness and width to a garage door. Fig. 2 shows how molding can be used on a ceiling to give the illusion of height. Applied in the form of nesting frames, the molding permits the ceiling to be painted several colors without losing the unity the plane gives to a room. Detail B, Fig. 1, shows how regular screen molding can be used to transform dated porch screens to modern Shoji screens. The screen areas are divided into a grid pattern by nailing the molding back to back with the wire between. An example of how half-round molding will serve to emphasize length and lowness of a built-in sofa is shown in Fig. 3. Here the molding is run horizontally on the walls and the areas between are painted different colors. Novel bed headboards consisting of molding attached directly to a bedroom wall and framing inserts of cloth, cane mat or wallpaper, is another way you can use molding to good advantage. Clever cabinet and





drawer handles that are both decorative and practical are nothing more than strips of picture molding applied in the manner shown in Fig. 4. What you can do with molding to decorate your window shutters and entrance doors is suggested in Fig. 5. Note particularly how quarter-round molding applied to the face of a plywood panel closely simulates louvered shutters. Interiors can be given added interest and the feeling of warmth by facing the doors with squares of cloth or paper which match the room drapes or wallpaper. In the example shown in Fig. 6, squares of cloth matching the pattern of the bedspread are framed by applying strips of molding over the edges of the cloth. Gives the effect of paneled doors and makes them belong to the rest of the room.

Coping Molding

The trick of good joinery with moldings is to miter all outside corners and to cope all inside corners. Figs. 9, 10 and 11 show how to cope molding when fitting it around the ceiling of a room. First, the piece of molding is held against the back-guide of a miter box in the same position it will be when installed, and it is cut off at a 45-deg. angle with the saw. In the photo the piece to be coped is at the right, behind the saw. If you were making a mitered outside corner with this same type molding, you would cut it the same. The piece to be coped is trimmed off with a hand coping saw, using the inside edge of the miter sawcut as a guide line. Saw perpendicularly, trimming away the wedge of wood left by the 45-deg. cut. The piece also can be coped on the jigsaw by laying the back side of the molding flat on the table. When coped, the end will have an exact reverse profile of the molding against which it is to be butted,

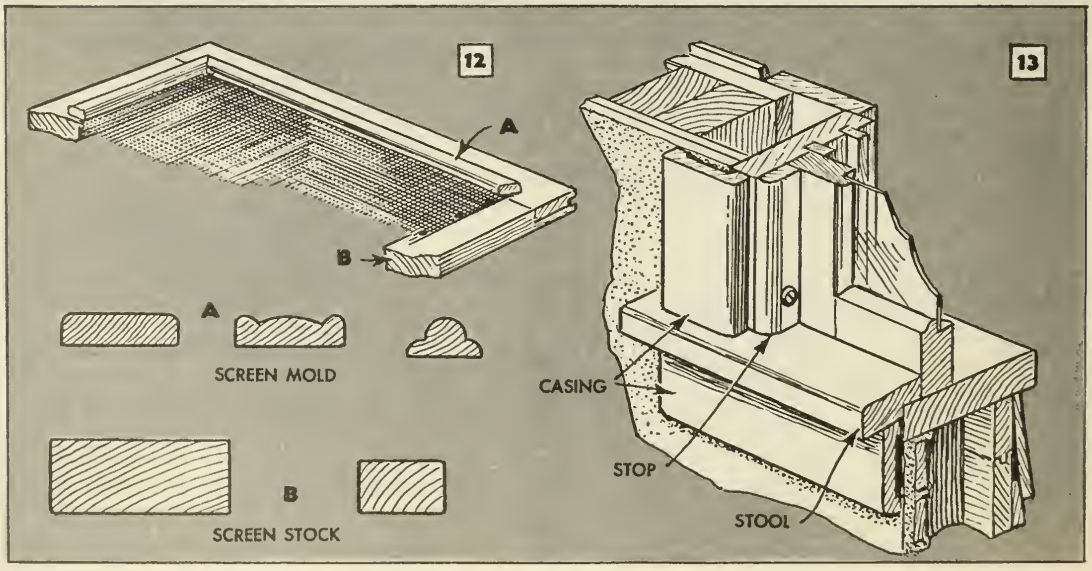
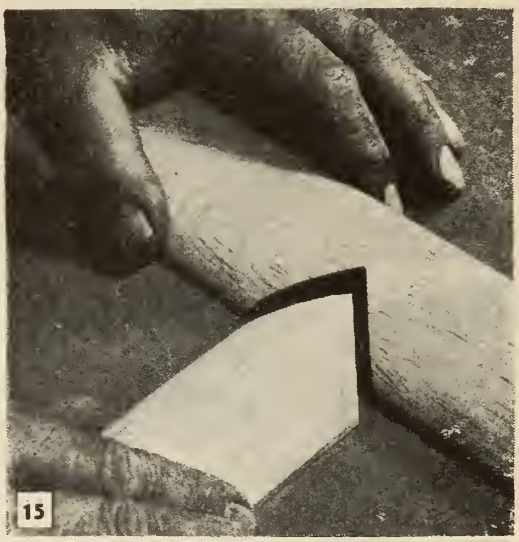


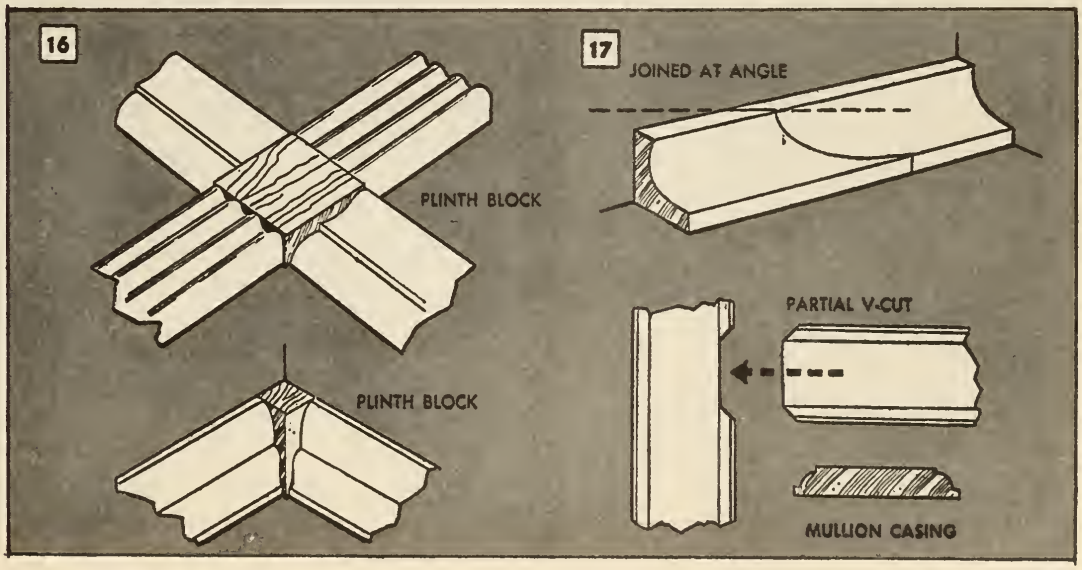
Fig. 11. In placing molding completely around a ceiling, two methods can be used. You can cope only one end of the four lengths, cutting the others square, or cope both ends of two lengths, leaving the ends of the other two lengths square. In the later case, the uncoped lengths are applied first. In all cases, the coped ends butt against the face of the adjacent molding. The reason for coping instead of mitering an inside corner is that corners of rooms are seldom square and you can compensate for this more easily with a coped end since you can trim away front or back edges to make the joint fit perfectly. Even if the joint is a little ill-fitting, or if some shrinkage in the wood should occur, the joint will still look neat because the cut itself cannot be seen except when sighting along the line of the molding.

Joining Molding

When two or more pieces of molding intersect as in Figs. 14 and 15, it is best to use a symmetrical molding, such as a round casing, or a half-round. Then the pieces can be smoothly joined together. The piece to be let-in is trimmed to a point by two 45-deg. cuts and it is used as a pattern to mark the notch in the other piece. When different or symmetrical moldings are being joined, a plinth block is used as in Fig. 16. Likewise, a plinth block can be used in a corner to avoid coping. Standard moldings come up to 16 ft. or more in length but sometimes it is necessary to splice, or join, two pieces. Fig. 17 shows how both pieces are mitered 45 deg. and lapped. When glued, a stronger joint results and is less noticeable. A partial V-cut gives the most attractive joinery where pieces of mullion casing or the like, which are shaped only along the edges, are to intersect. ★ ★ ★



Western Pine Association photos



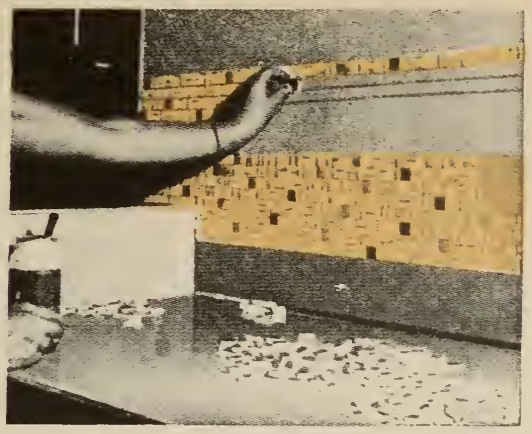
Now, mosaic can be applied to almost any surface in or on your house

DECORATE WITH MOSAICS

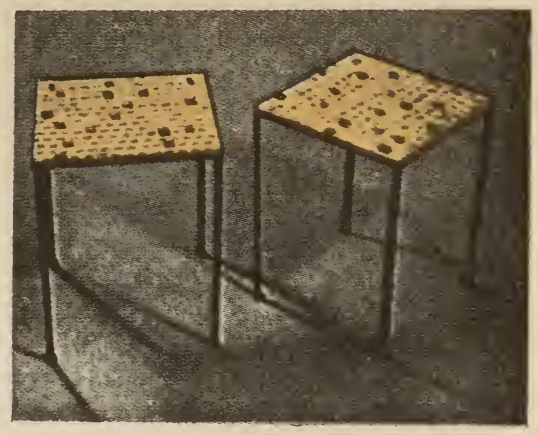
THE ANCIENT ART of mosaicking (inlaying surfaces with ceramic or glass-like tiles now available in many colors) is well within the ability of almost anyone. Applied with special adhesives, mosaic tile may be used to modernize and beautify old surfaces, or to inlay new pieces, such as free-form tables designed and built to your liking. Lamps, book ends, jewelry and cigarette boxes, glittering bowls and ash trays can be made with base materials that depend entirely on your own ingenuity. Or, you can tile counter tops, walls around sinks, lavatories and bathtubs and, if desired, even work out beautiful designs on other walls.

Most mosaic tiles are approximately ¾ in. square and are available in a rainbow of colors. There are three basic types, the cost of the tile depending on the type. The tiles may be "cut" to various sizes and shapes with carpenter's pincers. In doing

Tray and table above are two good examples of using mosaic tile to produce modern-appearing objects. Below, large cardboard tube is mosaicked to produce an unusual, but beautiful, base for a modern lamp



The beginning of an attractive, easy-to-clean splashboard above the work counter in a kitchen



Modern metal tables lend themselves nicely to mosaic tops. Final appearance depends on the design used

this, there will be some waste as a tile does not always break as desired. But in most cases, the waste material can be used in working out other designs.

To apply mosaics, first work out the design full size on paper, Fig. 1, coloring it to match the tiles being used. Then transfer the design to the base or object to be covered, Fig. 2, first thoroughly cleaning the surface. Next, apply adhesive to the surface and place the tiles, following the design and color previously worked out. It is best to coat only a few square inches of surface at a time as the adhesive may set before the tiles can be placed.

It is easier to work out any central designs or themes first, Fig. 4, and fill in the background afterward. Leave spaces of 1/16 in. or more between the tiles for grouting.

After all tiles have been applied, mix a grout as in Fig. 3. It consists of white tile cement and water, mixed to a consistency slightly thinner than patching plaster. This is spread over the mosaic by hand to fill in the joints between the tiles. While the grout is still wet, wipe the face of the mosaic with a damp sponge to remove excess grout.

In case of a table or other flat surface, metal or wood edging may be used to cover the edges and produce a finished appearance. The basic forms on which you can cement the tile to make different objects are endless. For example, a section of cardboard carpet roll provides an excellent cylindrical lamp base. Each end is plugged with a wooden disk, glued in place. Rec-

A plywood top mosaicked and edged with brass and fitted with screw-on legs produced this table

Right, an old metal tray takes on a crisp, new look when mosaicked in a pleasing design of suitable colors

First step in mosaic work is to lay out the design on paper full size and color it to suit your desire

The design then is transferred to the surface to be mosaicked and the tiles laid according to pattern

tangular lamps can be produced by assembling suitable forms from plywood. A hole bored in the top before the tiles are applied will accommodate the lamp fittings, which are available in any hardware store.

Blocks of wood provide excellent bases for mosaic book ends. They may be used in rectangular shapes, or sawed diagonally to make interesting pyramidal forms.

Old cigar boxes provide good foundations for jewelry and cigarette boxes. Interesting effects can be achieved by setting the tiles close together with no grouting. Almost any battered old tray or bowl can be made to look like a collector's item with simple application of mosaic. Steel mixing dishes used by chefs in restaurant kitchens are good, as are wooden salad bowls. Cheap metal or paper trays and bowls from the dime store do equally well. Much depends on the mosaic design.

A mosaic-surfaced table is a piece you will be proud of forever. If you make your own in free form or in rectangular shape, nothing lighter than ¾-in. plywood should be used. Shellac both sides to prevent warping. Sets of flange-base, screw-on legs in walnut, mahogany, birch or metal may be purchased inexpensively. These legs come with mounting plates for setting them either vertically or at an angle, depending on the period design of the table.

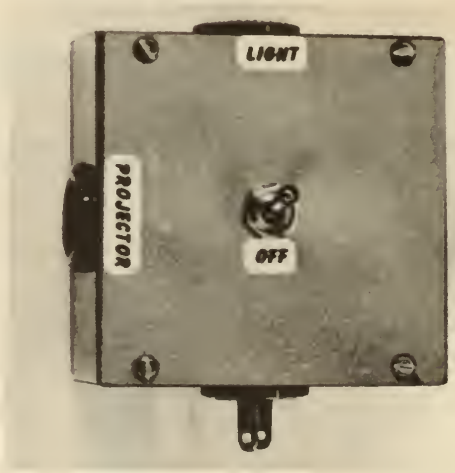
Mosaic may be applied directly to walls to make interesting splashboards above sinks, bathtubs and lavatories, much in the same manner as applying plastic tile. To assure neat, straight rows of tile, draw pencil lines on the wall for each row, leaving joint spaces for grouting. Apply the grout as for other types of work and wipe off the surplus. Here, as for other jobs, work out the design on paper first and then transfer it to the wall. Be sure to use appropriate designs for kitchen and bathroom. ★ ★ ★

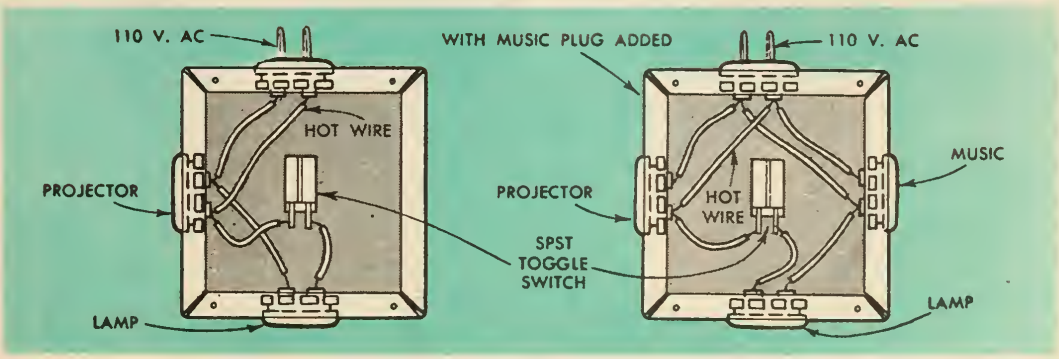
After tile has been placed and adhesive set, grout is mixed in bowl and applied to the tile joints

Remember, it's easier to work in central design first and then fill in the various backgrounds afterward

Unit Controls Room Lights for Home-Movie Projection

THIS LIGHT-CONTROL UNIT places complete control of the floor lamp or other room lights at the home-movie or slide projectionist's finger tips, making it unnecessary to grope in the dark for the light switch. The unit consists of two 61 Amphenol female receptacles (with removable mounting plates), a toggle switch and a 61 Amphenol male plug, all mounted in a small metal box. The male plug, leading to the current source, is wired directly to the projector receptacle. This in turn is wired to the lamp receptacle with the "hot" wire running through the switch as illustrated. If desired, a tape recorder or phonograph may be used with the projector. In this case, an additional female receptacle is wired directly to the male plug and to one of the light leads, as shown in the illustration at the right. The additional receptacle is also "hot" and current is controlled at the phonograph.



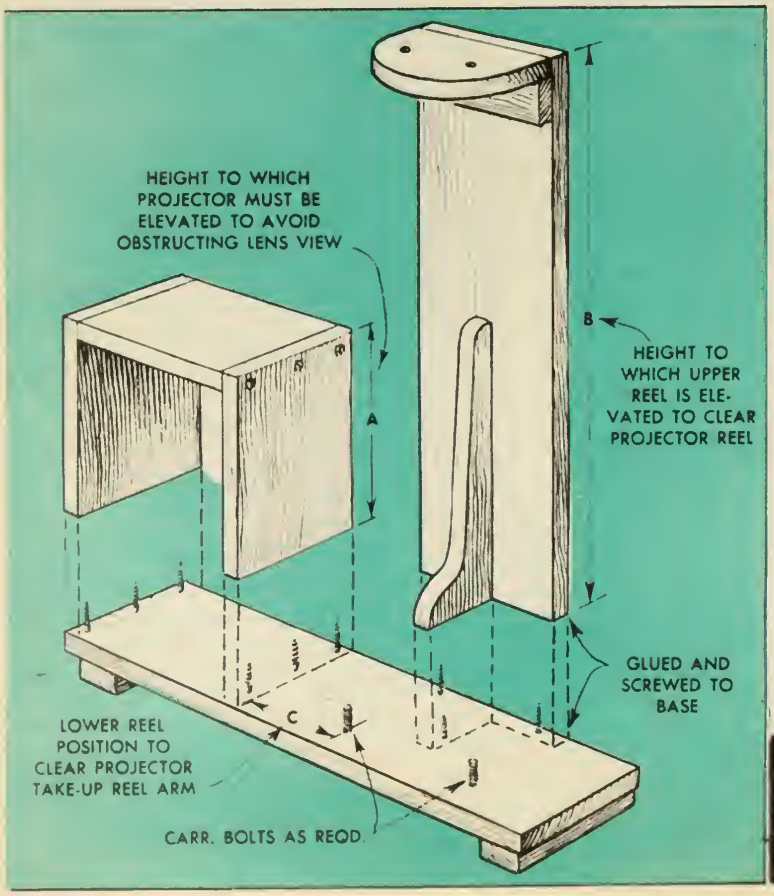


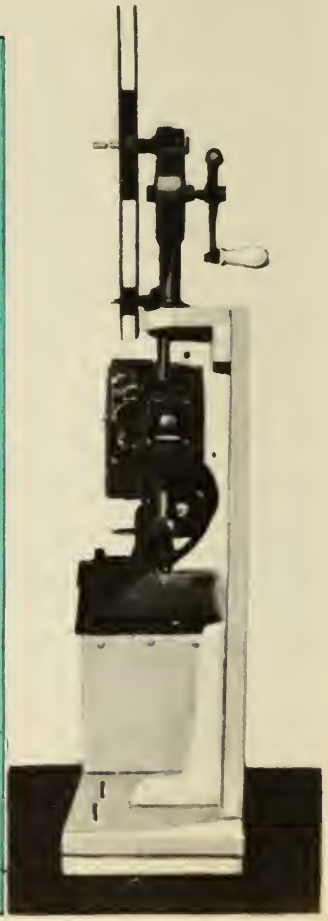
PROJECTOR PLATFORM INCREASES FILM RUN

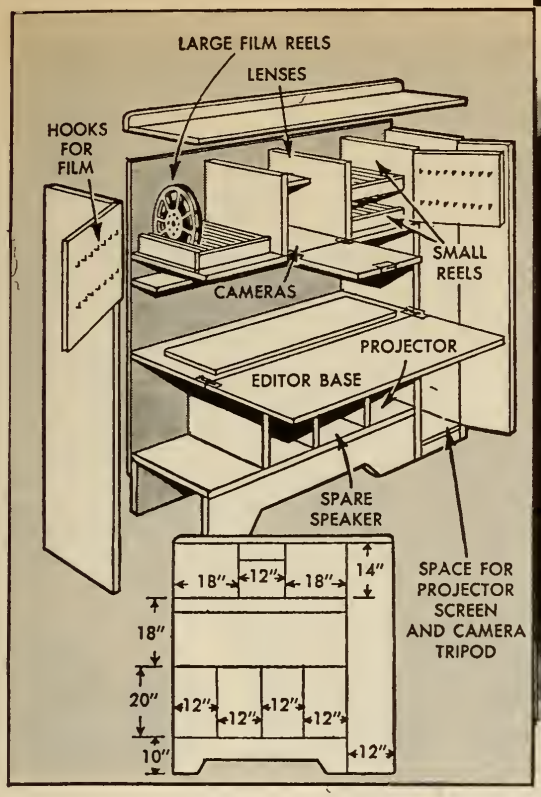
TO AVOID frequent stops for reel changes when showing films with runs of 15 to 50 min., one amateur movie producer made the wooden platform shown to permit using large-size reels on his home-movie projector. Most projectors of this type have a reel capacity of only 300 to 400 ft., about 10 min. of running time. Actual dimensions for the platform members are not given because of varying reel positions and sizes of different projectors. Of course it is necessary to hand-crank the lower rewind since it is not coupled to the takeup arm.

Start construction of the platform with the base member. The only critical dimensions are those referred to by the letters A, B and C of the drawing. To find these dimensions, simply block-up the projector on the base and position the lower rewind to provide the required clearances. Do the same for the upper rewind, being sure to mount the largest reels to be used on both rewinds. All reels must be in alignment.

Frank P. Fritz, Bensenville, Ill.





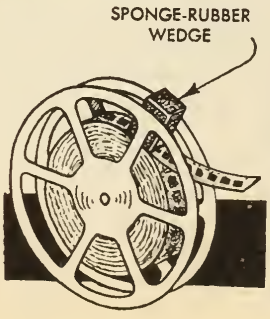


Complete Home-Movie Center Located in Cabinet

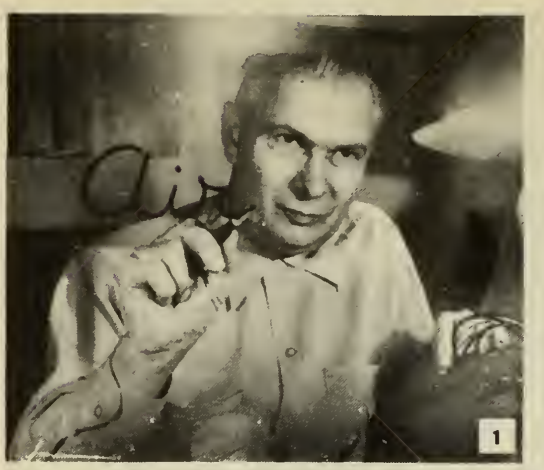
As with any hobby that is allowed to grow, home-movie making eventually gets to the point where storage of equipment becomes a problem. This cabinet was designed as a solution to this situation, being a complete home-movie center. Editing viewer is mounted on a plywood panel that is kept in the large central compartment behind a bottom-hinged door that drops down to form an editing desk at comfortable seat height. Above the editing compartment is a locked cabinet for a camera and lenses. On either side of this cabinet are divided storage sections for large and small film reels. Numbered hooks or pegs are located on the insides of the reel-compartment doors to permit hanging short lengths of film during an editing operation. The lower section of the cabinet has several compartments for storage of such items as projectors and lights, and there is even room for a tape recorder or accessory speaker, if a sound projector is included in the equipment. On the right side of the cabinet, with its own door, is a vertical compartment that will accommodate a folding projection screen up to a size measuring 50 x 50 in. Several tripods and folding lamp stands also can be fitted in this compartment. A cabinet built to the dimensions shown, and with a front-to-back measurement inside of 15 in. will accommodate the largest 16-mm. equipment. If 8-mm. equipment is used exclusively, or if the projection screen and other equipment are small, the cabinet can be reduced in size by about 10 percent. Availability of space may also dictate that the cabinet be made smaller than shown. Although the entire cabinet can be made of ⅜ or ½-in. plywood, it is suggested that the bottom and top, as well as the desk surface be made of 1-in. solid stock.

Bell and Howell Company.

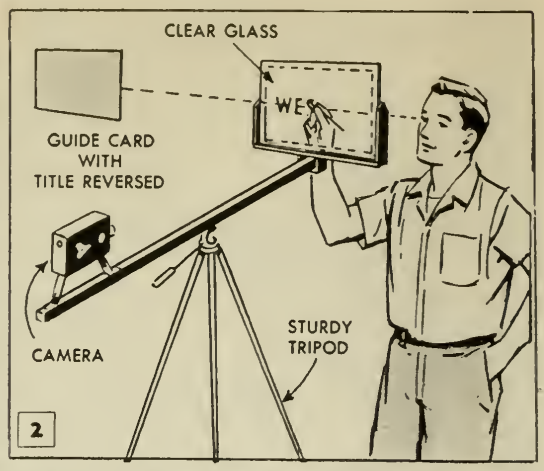
Wedge Holds Movie Film on Reel



Movie film will not unwind if a square of sponge rubber is wedged between the sides of the reel as shown. Wedges of a suitable size cut from a discarded kneeling pad are ideal stops for this purpose.



Panel of glass on which title is written must be sparkling clean and free of bubbles, cracks and other defects that distort objects filmed through it



Writing title in reverse on glass is easy, when a guide card with title written in reverse is prepared and located at eye level directly above the camera

Trick Titles
for Your Home Movies

By E. R. Haan

HERE ARE SOME suggestions for unusual titles that will start your home-produced movies with punch and give them a professional touch. Your friends will wonder how you've managed to write a title "on air," how a pile of letters can arrange themselves into words and how a wave of your hand magically produces a title. Many mystifying, animated effects such as these are surprisingly easy to produce without much expense or special equipment.

Writing on Air

One of the simplest ways of producing a trick title is to write the words on a pane of glass so that they appear to remain suspended in air as shown in Fig. 1. One way to do this is to mount the camera on a tripod, facing the subject who is to do the writing. A large pane of glass is then propped or clamped in a vertical position in front of the subject at right angles to the lens axis as in Fig. 3. If the camera is of the focusing type, it is adjusted for a depth of field to include a distance of 6 to 8 in. beyond the glass, so that the subject's face and hands are in focus. The background scene desired should be composed within the limits of the pane of glass, as carefully checked in the viewfinder. The effectiveness of this illusion depends largely on the selection of a location and background material that would not be associated with the use of a pane of glass for this purpose. After practice-writing the title backwards several times, you are ready to start shooting it. When illumination is necessary, photoflood lamps are positioned on either side of the camera as shown in Fig. 3. It is important that the lamps be placed as shown, to prevent reflections from entering the camera lens. Also for this purpose, you can make a holder for a pane of glass as shown in Fig. 2. For purposes of illustration, the glass shown, is about half the desired size. A guide card with the title written in reverse on it may be used as a writing aid, when filming this type of title.

Reverse Motion Effects

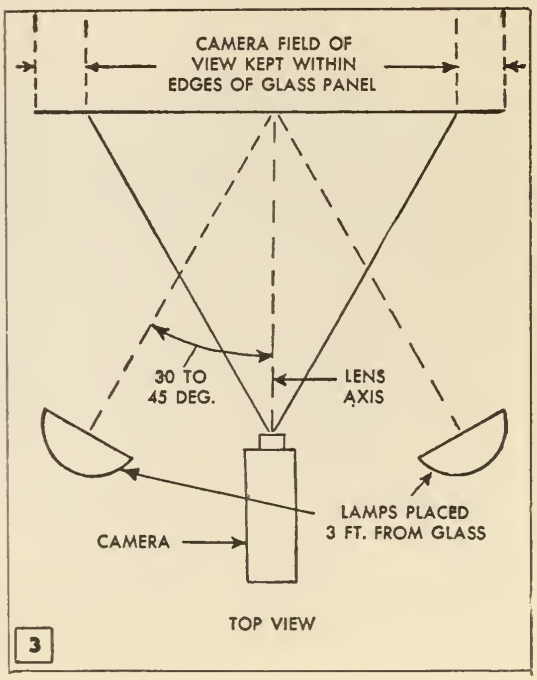
Highly unusual title effects can be made by projecting film strips in reverse, after shooting them expressly for this purpose and splicing them in a movie. For example, a reversed film strip may show letters flitting over a background and assembling themselves into a title. To produce this effect, you simply film the letters while they are being blown from the background as in Fig. 4. For shooting a title on a ver-

tical surface, the camera must be mounted in an upside-down position on a tripod. This can be done by making a U-shaped bracket to accommodate your camera as shown in Fig. 10. When filming a horizontally placed title, the camera is aimed at the title so that it is filmed in an upside-down position, Fig. 4. This camera position makes the title appear right-side up, when it is spliced into the film reversed end to end and with the emulsion on the same side as that on the film. By doing this, the last action filmed will appear first in the projected picture with all action in reverse.

When using an 8-mm. camera for film-reversal title, remember that the processed film has perforations on one edge only. Therefore, a reversed strip must be positioned so that the perforations appear on the same side throughout the movie. As this reverses a title as it would appear in a mirror, it is necessary to write or print the title in this reversed position, when shooting it. The title strip must then be refocused when projecting it.

Letters can be blown off a horizontal background with a vacuum cleaner, Fig. 4. A small diameter tube taped to one of the cleaning attachments, provides the proper air stream, when the hose is coupled to the blowing outlet on the vacuum. This setup

Below, to avoid reflections when writing title on glass, photoflood lamps must be placed 3 ft. from it and at an angle of 30 to 45 deg. from lens axis



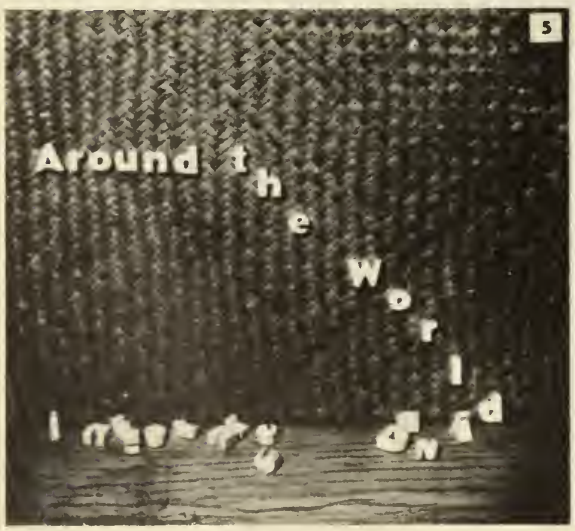
Distance from vacuum-cleaner nozzle to letters determines speed at which letters are blown off picture

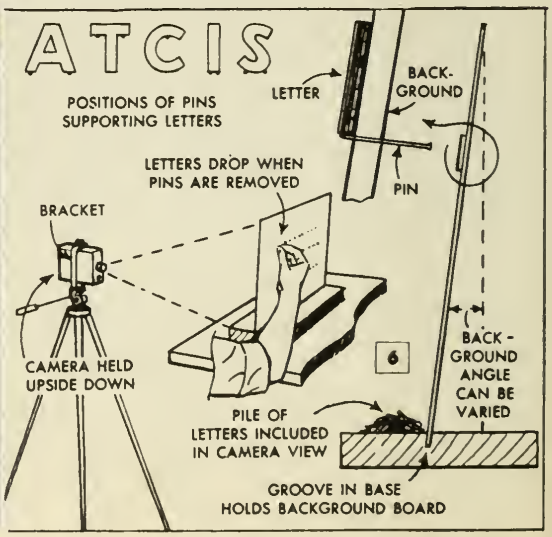
enables you to move paper or plastic block letters off the background while the tube is held out of view of the camera. The speed at which the letters move can be controlled by varying the distance between tube and letters. Lightweight paper and metallic-foil letters are least controllable and will move erratically, unlike heavier block letters. On multiline titles, the air stream may be directed from above so that the letters are dispersed in all directions. A little practice and experimenting soon makes you adept at obtaining the desired speed and direction of letter movement. Start blowing away the letters at the end of the title and continue toward the beginning, so that when the reversed film is projected, the title appears on the screen in the proper reading sequence.

Variations of Reverse-Motion Effects

You can make use of gravity in dropping letters individually, or drop them line by line from a title held on an angled background, Fig. 6. Then, the reversed projected film will show the letters disengaging themselves from a pile and rising into position on the background to form a title as in Fig. 5. When filming a title of this type, the letters are arranged to rest on pins that project through the background board. The latter is held by means of a grooved block, Fig. 6. The background is angled as shown to prevent the letters from falling forward, when the pins are pulled. This angle may be varied to control the speed of letter fall. The camera is placed so that the lens axis will be at slightly less than a right angle to the background to keep the pins out of view. Camera view should include the surface of the base block on which the letters collect. When you are ready to shoot the title, begin with removing the pins of the last letter of the last word. Do this carefully to avoid dislodging other letters. Some letters need only one pin for support but most require two. When drilling the holes for the pins,

Letters filmed as they drop from pins appear to reassemble on background, when film is projected in reverse

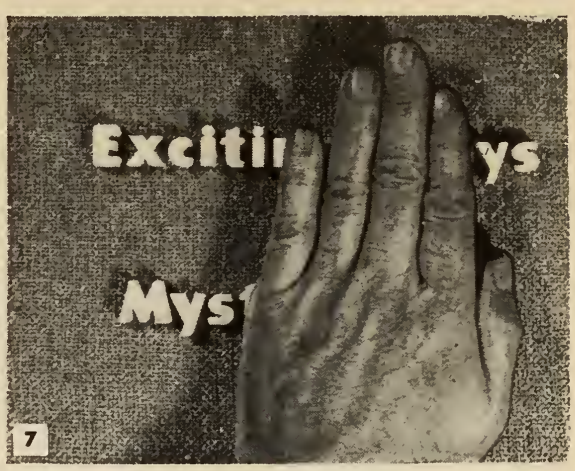




place the background on a horizontal surface and assemble all the letters on their lines. Then, mark the locations of the pin holes and drill them.

Another interesting illusion obtained by reversed motion consists of making the lines of a title suddenly appear when your hand is passed over the background as in Fig. 7. To get this effect, shoot the action of pushing away letters that are loosely laid on a horizontal background as in Fig. 8. For 16-mm. film, use your left hand to sweep the letters toward the left out of the field of view, starting with the lowest line and working backward to the first word of the title. For 8-mm. film, the title is set up in reverse and the right hand is used for removing the letters from left to right. The letters are collected under the palm and are pushed along with thumb. When projected, the reversed title strip shows the first line appearing first from left to right in normal reading sequence. Chalk-written titles on a blackboard may be produced similarly by filming the erasing angle.

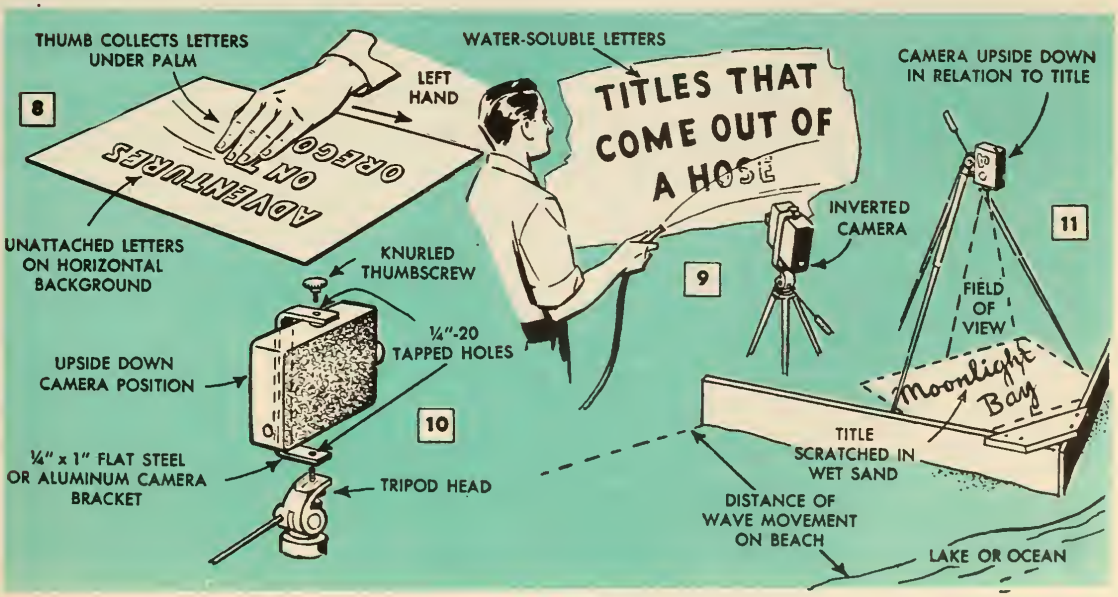
Water from a wave that runs up on a beach seemingly produces a title in wet sand after filming the title in the following manner. First, block off the title area with wide boards arranged to form a V-shaped barricade as in Fig. 11. This will keep the water from interfering while you are scratching the title in the sand and when shooting it for the desired reading time. Then, you remove the boards and immediately start the camera, before the next wave obliterates the title. For good results, experiment with the depth of the letters required to permit a wave to completely remove all traces of the title.



Title that is filmed in reverse as hand sweeps it off background appears as if by magic, when projected

For a reversed-motion title that is quite difficult to do but not impossible, if you have the time and patience, have squirrels spell out a short title for you. This is done by placing nuts on a light-colored background, to spell out the title. Locate your camera on a second-story elevation almost directly above the title area and run it only when squirrels come to remove the nuts. For this you need a telephoto lens. For best results, camera position and location must not be changed once the first exposure is made. Also, the title area must be free of changing shadows.

Your garden hose can be made to "squirt" a title on a wall or other suitable background. This is the reversed action of washing off a title as shown in Fig. 9. The letters must be made of material that is



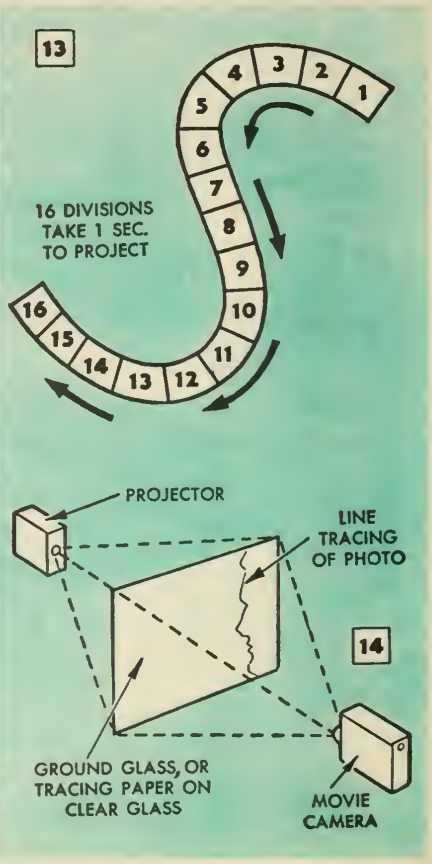
water soluble, such as moist mud, some cold-water paints, etc., so that the title can be flushed off the background without a trace. When doing this, start with the last letter, pointing the hose nozzle toward the right. Maximum water speed is necessary since this makes it harder to observe the water "returning" to the hose upon reversing the film run.

Titles by Simulated Movement

The impression of movement can be produced by making a sequence of single-frame shots for each letter of a title as it is advanced toward its assembly position in the title. Movement of the letters can be slowed by exposing two or three frames for each position. If your camera can't make single-frame exposures, use the release in the usual manner and expose as few frames as possible. To set up such titles for filming, arrange the background horizontally below the camera as in Fig. 12. Make a single-frame exposure of the background with the first letter of the title placed at its edge. Then, advance the letter about ½ in., take the second exposure, advance it another ½ in. and place the second letter at the edge of the background for the third exposure. Continue advancing all the letters and adding new ones between exposures as required. When each letter arrives in title position, line it up with the others, using a ruler. For added amusement, you can intentionally misspell words and make the corrections when the title is completed. While the letters are enroute to their title positions, they can be made to appear to jump, turn somersaults and perform other amusing antics.

A "self lengthening" line is another example of simulated movement. To obtain this effect, slightly lengthen a line between single-frame exposures. An entire title can be so formed, each letter growing as indicated in Fig. 13. A further application involves making a sketch next to the title being filmed. To do this, trace a photo projected on a square of ground glass as in Fig. 14. Start to mark the "moving" line on the smooth side of the ground glass with a grease pencil. Then, film this with single-frame exposures as you lengthen it, turning the projector off when making the exposures. If ground glass is unavailable, you can make a good substitute for it by taping tracing paper to a pane of glass. A "self-lengthening line" can be made to trace the

Fig. 12, to simulate letter movement, sequence of single-frame exposures of each are made as title is assembled



Title that appears to grow in size is made by shooting sequence of single exposures as camera is moved in

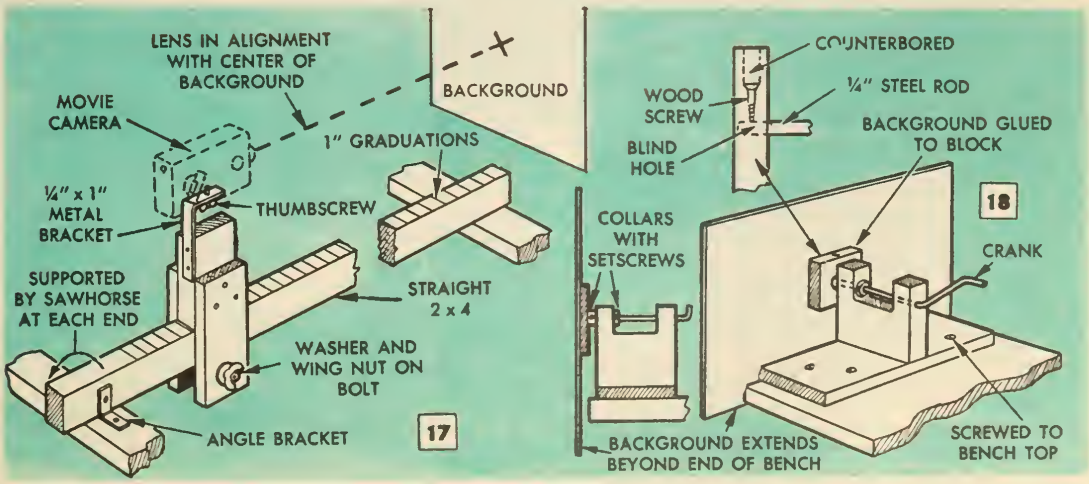
route of a trip on a map and spell out the points visited. This can be varied by using a tiny, toy auto on the map that will appear to run along the route traveled.

Completely different in effect, a title can be made to appear small in the distance and advance toward the camera, increasing to full size as in Figs. 14 and 15. This is done by making single-frame exposures as the camera, mounted on a track as in Fig. 16, is moved short distances toward the background.

Titles That Whirl

There are different ways of making a title whirl and slowly come to a stop for reading. One method involves reversed action. After the title is adhered to a background that can be revolved as in Fig. 18, the necessary film footage is exposed for the desired reading time. Next, the background is rotated very slowly at first, then with increasing speed. If desired, this trick can be combined with the title-advancing trick, in which case the camera is moved backwards slowly on a track while the title is spinning. The rotating title blurs and decreases in size. The reversed projection will show the small blurred title advancing, enlarging and coming to a stop for reading.

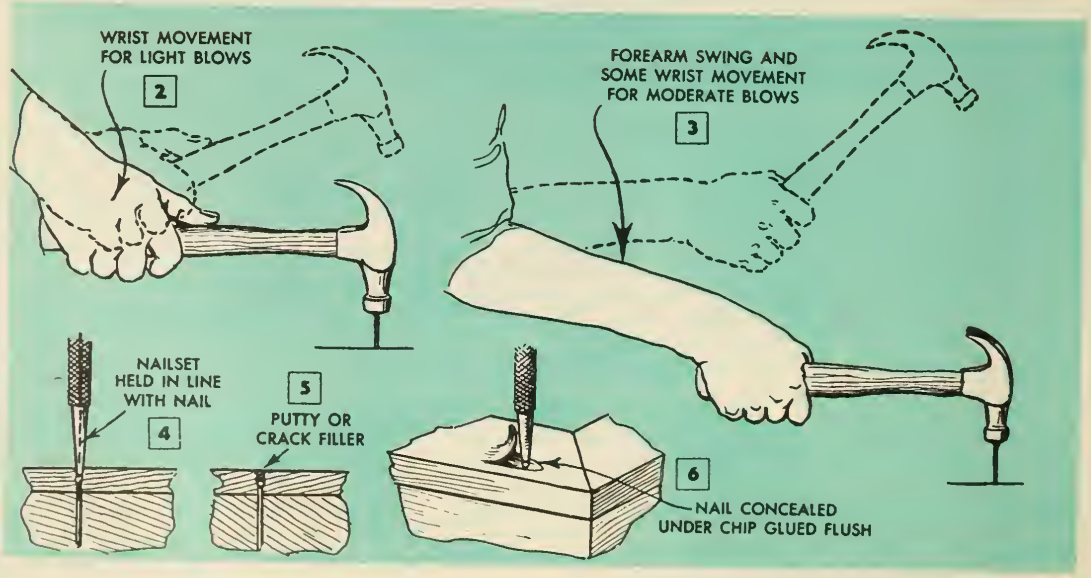
A title also can be made to appear as if it is spinning by using single-frame exposures. The title background, pivoted centrally, is rotated about a quarter turn, and given a single-frame exposure. This is continued for two complete turns. On the third turn, two frames are exposed, four frames on the fourth turn. For the fifth turn, the turn distances are halved and 4-frame exposures are made at each stop. For the sixth turn, the distances turned are halved again and 16 frames are exposed. The first eight are 4-frame exposures and the rest, 5-frame exposures. On the seventh and succeeding turns, the number of stops per revolution is decreased and the number of frames exposed is increased, until the title assumes a horizontal position required for reading. Then, the title is exposed for the proper reading time, processed and spliced on the movie for which it was made. ★ ★ ★



SELECT THE

THERE ARE NOW over a hundred types of nails available and from these you can select a nail for any specific job where nails can be used as fasteners. They are obtainable not only as types but also in many sizes in nearly all types. In addition to variations in shape and size, nails are supplied in varying degrees of hardness for special purposes. When exceptional holding power is necessary, as on parts which will be subjected to unusual strain or vibration, it is advisable to use adhesive-coated, etched or barbed nails. Where rust is likely to cause discoloration of the work or affect the holding power of the nail, it's a common practice to use Parkerized, cadmium-plated or heavily galvanized nails in a size and type suited to the requirements. In some cases stainless steel, copper, bronze or aluminum nails will best serve the purpose. An example is the use of aluminum nails for attaching wooden siding. Aluminum nails do not corrode and the heads of the nails can be painted over without any special treatment to prevent rust and the resulting discoloration of the paint.

Hammers: Nearly all types of common nails can be driven with a single hammer

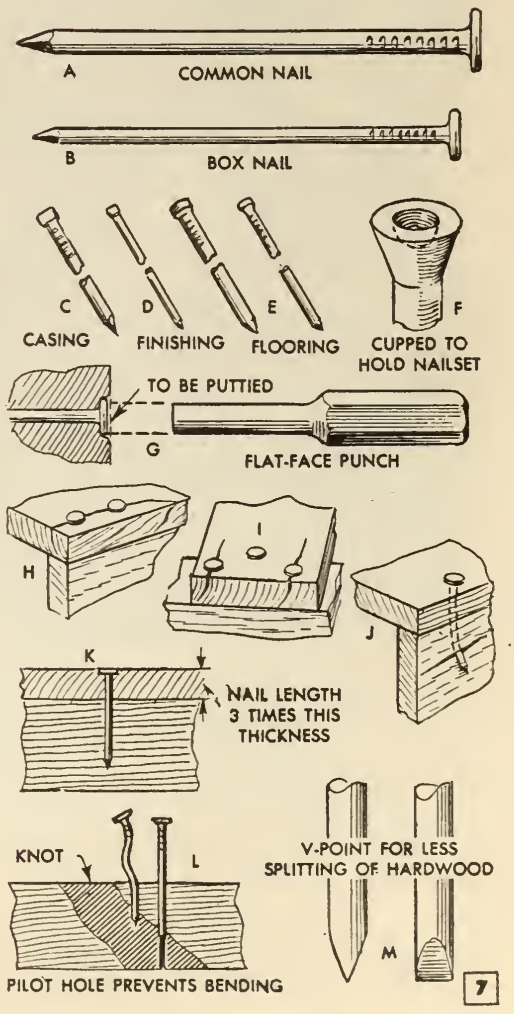


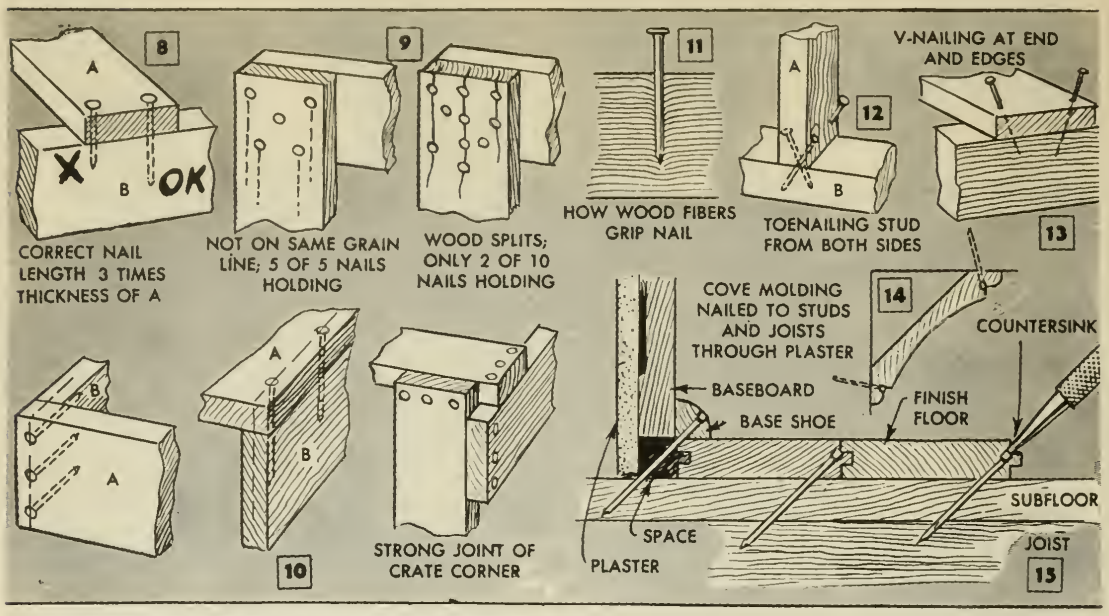
RIGHT NAIL

By E. R. Haan

Nailing techniques and kinds of nails are varied to suit the job to be done

having the weight and balance that suits the user's individual preferences. Hammer-head weights in the standard types range from 7 to 28 oz. with the 13 and 16-oz. heads an all-around choice of carpenters and others who use hammers for nail-driving exclusively. For delicate work, such as nailing flooring and trim in building construction, carpenters generally prefer a hammer with a lighter head as it is more easily controlled. A high-grade nail hammer, or claw hammer as it is commonly called, will have a highly finished head with claws of a uniform length, the poll will have a 2-deg. toe-in and the handle will be correctly shaped to provide the user with a comfortable hand-hold in the proper position in relation to the length of the handle. These points of construction give a hammer what experienced users call hang and balance, quality features that determine its accuracy and ease of handling. For ordinary work the face of the poll is crowned slightly and the edge beveled all around. For some specialized jobs the poll is checkered. Fine, sharp checkering on the face of the poll prevents it from slipping off the head of the nail when working under difficult conditions. Figs. 1, 2, 3 and 16 show how to hold a hammer when delivering both light and heavy blows. An important point in correct handling is brought out in Fig. 1. Note that the axis of the hammer is approximately at right angles to that of the nail as the blow is completed. If the handle is a few degrees down or up, the head of the hammer may "glance" off the nail and injure the fingers or bend the nail. If the hammer has the correct balance and weight for the job, it will fall naturally

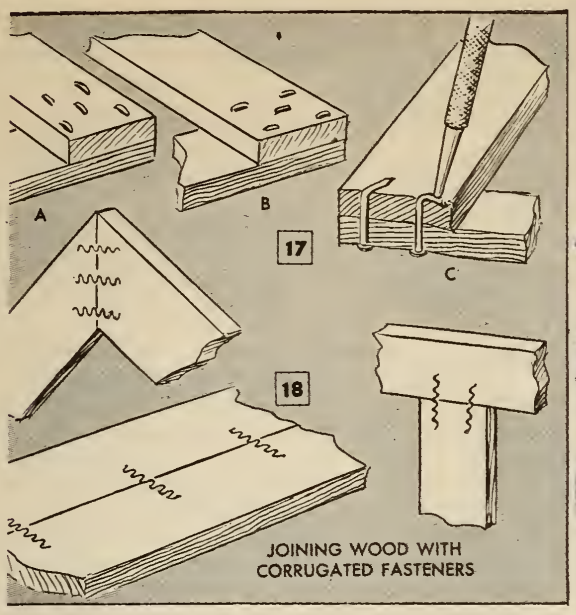


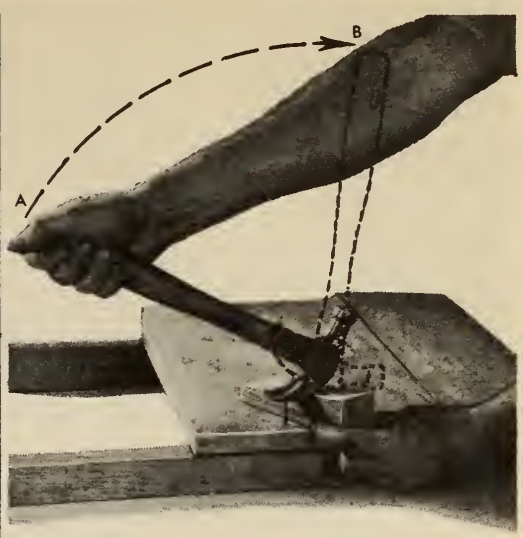


into this position at the end of the stroke. When light blows and positive control are necessary, it's a common practice to grip the hammer handle as in Fig. 2, with the thumb extended along the handle, as indicated. On the other hand, when it takes the maximum arm swing to deliver a series of heavy blows, the arm action will be smoother if the handle is gripped as in Fig. 3.

General-purpose nails: The measure of the length of common nails is indicated by an old symbol, the letter "d," meaning penny. The d-sizes range from 2d to 60d. The 2d to 16d nails increase by ¼ in. as in the table on page 198. Those above 16d increase by ½ in. The common wire nails, detail A, Fig. 7, are used mostly for joining house framing. Such nails should not be used on siding or in joining any other part of the structure where they will be exposed directly to the weather. Use aluminum or copper nails in exposed places. Note the similarity between the common nail and the box nail, detail B, Fig. 7. The finishing nails, details C, D and E, Fig. 7, include three types which vary in gauge and also have slight variations in the shape of the heads. The heads of these nails are cupped slightly, detail F, to hold a nail-set when setting the heads below the surface, as in Figs. 4 and 5. Ordinarily, the holes made by setting are filled with putty or a crack filler, but on fine cabinet work the heads often are blind-set as in Fig. 6. Flooring nails have blunt points for easier driving with less tendency to split the hardwood. Casing nails, detail C, have tapered heads and are used for interior trim and cabinet construction. On exceptionally fine work in hardwoods, finishing nails often are used instead of casing nails. They are smaller in diameter and have smaller heads which can be sunk below the surface with a nail-set with less tendency to split the stock.

Nailing procedures: Nails driven too close to the edges or ends of stock are likely to split the wood, details H and I, Fig. 7. When edge-nailing as in detail J, adverse grain may force the point of the nail sidewise so that it breaks out on the face of the stock. When starting nails under these conditions be sure that the nail is centered. In certain hardwoods, such as

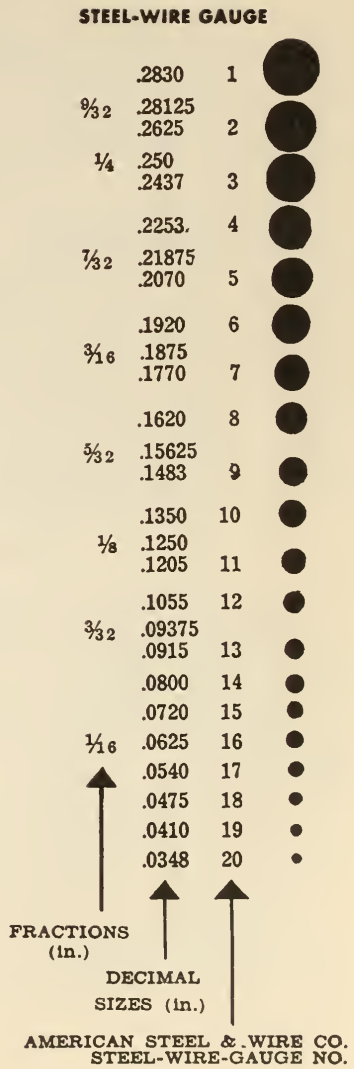


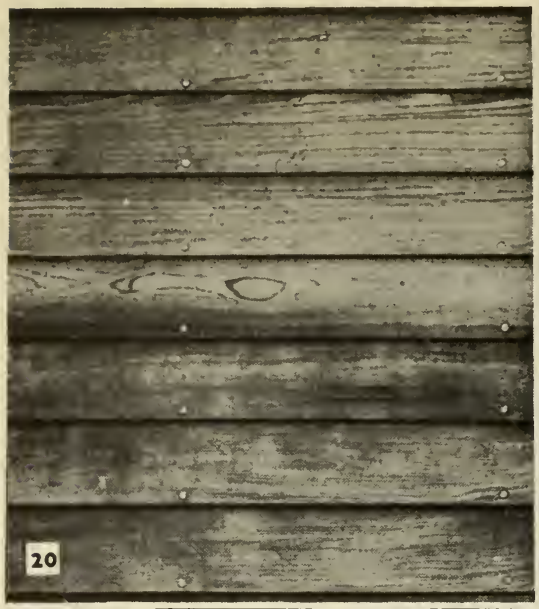


oak, it is advisable to drill a pilot hole slightly smaller than the diameter of the nail, or use a nail with a V-point, detail M. Often it is necessary to drive a nail through a knot as in detail L, Fig. 7. A pilot hole will prevent splitting of the stock. For maximum holding power on wood-to-wood joints, it's a common rule that the nail length should be three times the thickness of the piece being attached, detail K, Fig. 7, and A and B, Fig. 8. Whenever it is necessary to set flat nailheads use a flat-face punch as in detail G, Fig. 7. When joining two pieces of wood of equal width at right angles, as in the right and left-hand views in Fig. 9, take careful note of the direction of the grain. Then drive the nails so that no two of them are on the same grain line. Note the center line on the parts A and B in Fig. 10, the left-hand view, compared with those on the parts A and B in the center view. In both types of joints it is essential that the nails be centered through both pieces of stock. In hardwood this should be done by means of pilot holes drilled through the pieces A, the holes entering the pieces B about ¼ to ½ in. to guide the points of the nails.

The holding power of a nail is due to the wedging action of the wood fibers, Fig. 11. This varies very little in average work even though the nails are driven into the wood at an angle as in toe-nailing a stud, A, to the plate or sill, B, Fig. 12, or in V-nailing as in Fig. 13. Another example of V-nailing, or angle nailing, is that of joining flooring to the subfloor as in Fig. 15, also the base shoe in the same detail. In attaching cove molding, Fig. 14, it sometimes is necessary to drive nails at an angle. Nails can be clinched across the grain or with the grain as in details A and B, Fig. 17. Usually they are more easily clinched with the grain, as in detail A, but they do not hold as well and there is always the possibility of splitting the wood. When nails must be clinched flush with the surface, turn the points with a hammer, then clinch flat with a nailset as in detail C, Fig. 17.

Special-purpose nails: Corrugated fasteners, a form of special nail, are widely used in assembling frames, boxes and crates and in joining narrow widths of stock to make a wide piece. Fig. 18 shows three typical examples of the

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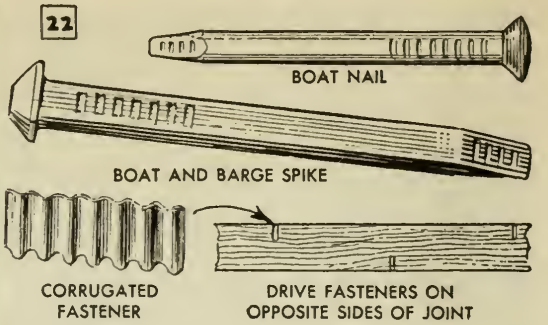
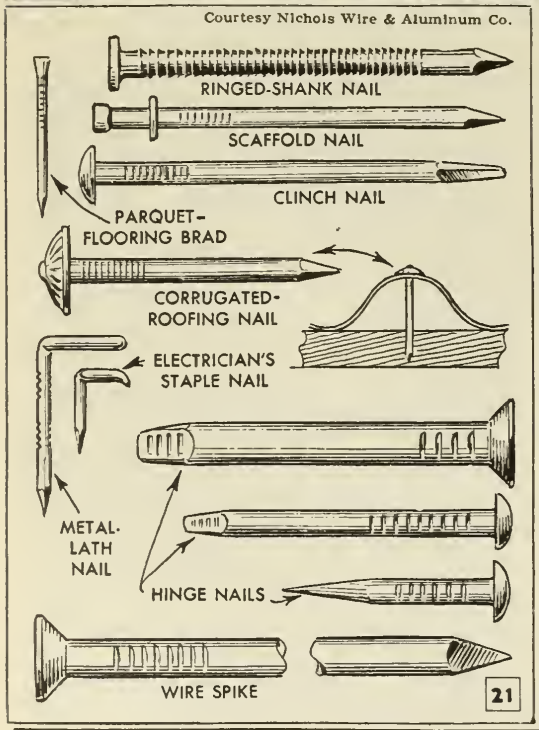


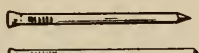
use of corrugated fasteners. A somewhat stronger joint will result if the parts are drawn together with clamps before nailing with the fasteners. Corrugated fasteners come in various widths and lengths which adapt them to a wide range of use on stock of different thicknesses. When joining narrow widths of stock edge to edge it usually is best to drive the fasteners in from both sides, spacing them uniformly along the full length of the joint, as in the lower detail in Fig. 22.

Other special nails are shown in Fig. 20, 21 and 22. Aluminum nails, Fig. 20, are widely used for attaching siding as they do not corrode. The ringed-shank nail, Fig. 21, has been designed for use where unusual holding power is required. The rings on the shanks are beveled at a 45-deg. angle, on the sides facing the point, so that they spread the wood fibers without severing them. The other sides of the rings are at a 90-deg. angle to engage the fibers which tend to resume their original position. This makes it necessary to break most of the fibers in order to remove the nail. Scaffold nails have two heads, Fig. 21, and are driven in up to the lower head. In this position the upper head projects, making the nail easy to remove with a claw hammer. Such nails are used for temporary construction, scaffolding and any other type of assembly which must be built so that it can be dismantled without damage. Clinch nails, Fig. 21, have duck-bill points especially designed for easy clinching. Parquet-

Courtesy Nichols Wire & Aluminum Co.



TYPE & PURPOSE	NAIL SIZES														
PENNY SIZE (d)	2	3	4	5	6	7	8	9	10	12	16	20	30	40	50
LENGTH (in.)	1	1¼	1½	1¾	2	2¼	2½	2¾	3	3¼	3½	4	4½	5	5½
COMMON NAILS: For most rough work like framing — GAUGE	15	14	12½	12½	11½	11½	10¼	10¼	9	9	8	6	5	4	3
HEAD DIA. (in.)	11/64	13/64	¼	¼	17/64	17/64	9/32	9/32	5/16	5/16	11/32	13/32	7/16	15/32	½
NO. PER LB.	847	543	294	254	167	150	101	92	66	61	47	29	22	17	13
BOX NAILS: Smooth or barbed; for boxes, crates, etc. — GAUGE		14½	14	14	12½	12½	11½		10½		10	9			
HEAD DIA. (in.)		7/32	7/32	7/32	17/64	17/64	19/64		5/16		11/32	⅜			
NO. PER LB.		588	453	389	225	200	136		90		69	50			
CASING NAILS: For cabinet work, interior trim, etc. — GAUGE			14		12½		11½		10½		10				
HEAD DIA. (ga.)			11		9½		8½		7½		7				
NO. PER LB.			489		244		147		96		73				
FINISHING NAILS. For finer work than casing nails — GAUGE		15½	15		13		12½		11½						
HEAD DIA. (ga.)		12½	12		10		9½		8½						
NO. PER LB.		880	630		288		196		124						



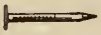
FLOORING BRADS
(A) 10 ga., 8d, plain or barbed. Head dia. 7 ga. 105 per lb.
(B) 11½ ga., 8d, plain or barbed. Head dia. 8 ga. 142 per lb. Easier driving in hardwood without splitting

WOOD-SIDING NAILS
Range from 5 to 10d and from 14 to 10½ ga.

ASPHALT-ROOFING NAILS
Galv., smooth or barbed. Lengths, ⅞, 1, 1¼, 1½, 1¾ and 2 in. Gauges, 12, 11 and 10. Head dia. from 9/32 to ½ in. Some checkered

STANDARD SHINGLE NAILS
From 1¼ to 1¾ in. in length. 14 to 12 ga. 271 to 434 per lb., depending on size. Use 1¾-in. for wood shingles laid over old shingles or roofing. Have regular or blunt diamond point

INSULATION SHEATHING
Galv. and barbed. Lengths, 1¾ and 2 in. 11 ga. 7/16-in. head. 155 and 136 per lb. Use 1¾-in. length for gypsum sheathing



INSULATION LATH
Blued, 1⅛ and 1¾-in. lengths, 13 ga., 3/8-in. heads. 499, 294 per lb. For gypsum lath use 1⅛-in. length

BARBED ASBESTOS-SHINGLE NAILS
Lengths 1¼, 1½, 1¾ and 2 in. 247, 210, 183 and 162 per lb. 11½ ga., 13/32-in. heads without fins

HARDBOARD AND BUILDING-BOARD NAILS
7 lengths from 1 to 1¾ in. by ⅛-in. steps. 17 ga., 3/32-in. head. Needle point. Bright galv. or cadmium plated. 885 to 1555 per lb., depending on size

GYPSUM WALLBOARD
Cement coated. Lengths, 1⅜, 1⅝ and 1⅞ in. 14, 13½ and 13 ga. 7/32, 15/64 and ¼-in. heads. 493, 366 and 278 per lb.

RED-CEDAR SHINGLES
3 or 4d for new roofs. 614 or 473 per lb 5 or 6d for shingles over old roofs 404 or 276 per lb. Head dia. 7/32 in. 3 or 5d for 16 or 18-in. shingles. 4 or 6d for 24-in. shingles. Gauges 14½, 14, 14 or 13 for 3, 4, 5 and 6d sizes

SMALL WIRE BRADS:

Length (in.)	Gauges	Length (in.)	Gauges
3/16	20-24	⅝	13-22
¼	19-24	¾	13-21
⅜	18-24	⅞	13-20
½	14-23	1 & 1⅛	12-20

Larger sizes also available, including brad-head nails from 2 to 60d with same shank size as common nails

UPHOLSTERER'S TACKS

No.	Length (in.)	No	Length (in.)
2	¼	10	5/8
2½	5/16	12	11/16
3	⅜	14	¾
4	7/16	16	13/16
6	½	18	⅞
8	9/16	22	1

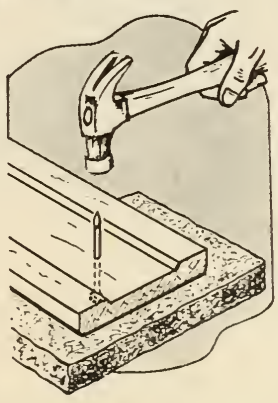
(Carpet tacks usually come Nos. 3, 4, 6, 8 and 10)

flooring brads come both plain and coated, the latter having somewhat greater holding power. Leakproof nails are used for attaching corrugated roofing. Only one of several types is shown in Fig. 21. Electrician's staple nails and metal lath nails are similar but are used for different purposes. The electrician's nail is used to hold runs of insulated wire in temporary installations. As its name implies, the metal-lath nail is used exclusively for attaching metal lath in building construction, as the nail is especially made for this one purpose. The chisel-pointed hinge nails, Fig. 21, are available in sizes ranging from 4d to 20d. The heads come countersunk and also oval shaped, as indicated in the details. Boat nails, Fig. 22, come both round and square, the square nails being available in lengths up to 15 in. Both come heavy galvanized and also in solid copper, which is expensive but noncorrosive, a definite advantage in boat construction.

Pulling nails: Hammers come with curved claws and straight, or ripping, claws. The ripping hammer has straight claws and is designed for removing siding and sheathing. The straight claws can be driven behind the boards to start the nails. However, the ripping hammer is not so suitable for pulling nails as is the hammer with curved claws. When necessary to remove a number of nails, make a wedge-shaped fulcrum block to use under the hammer head, as in Fig. 19. By using the block, the nail will be lifted straight upward without bending. The handle stroke can be made from A to B without undue strain on either the handle or the head of the hammer. Move the block farther under the hammer head after each stroke to gain advantage of greater height. ★ ★ ★

"No Splinter" Nail Removal

Avoid splintering the face of finished lumber when driving out old nails, by placing the lumber face down on a piece of insulating wallboard. The soft board will permit easy entrance of the head of the nail, but holds back the surface of the wood.



C-Clamp Prevents Nails From Splitting Small Lumber

To prevent splitting the end of a small piece of lumber that is being nailed, tighten a C-clamp on it as shown in the drawing. After the nails are driven, the clamp may be removed without danger of the wood splitting. Pilot holes should be drilled before driving nails in the ends of hardwood lumber.

Multipurpose ORTHOPEDIC WALKER

Designed by F. H. Overman

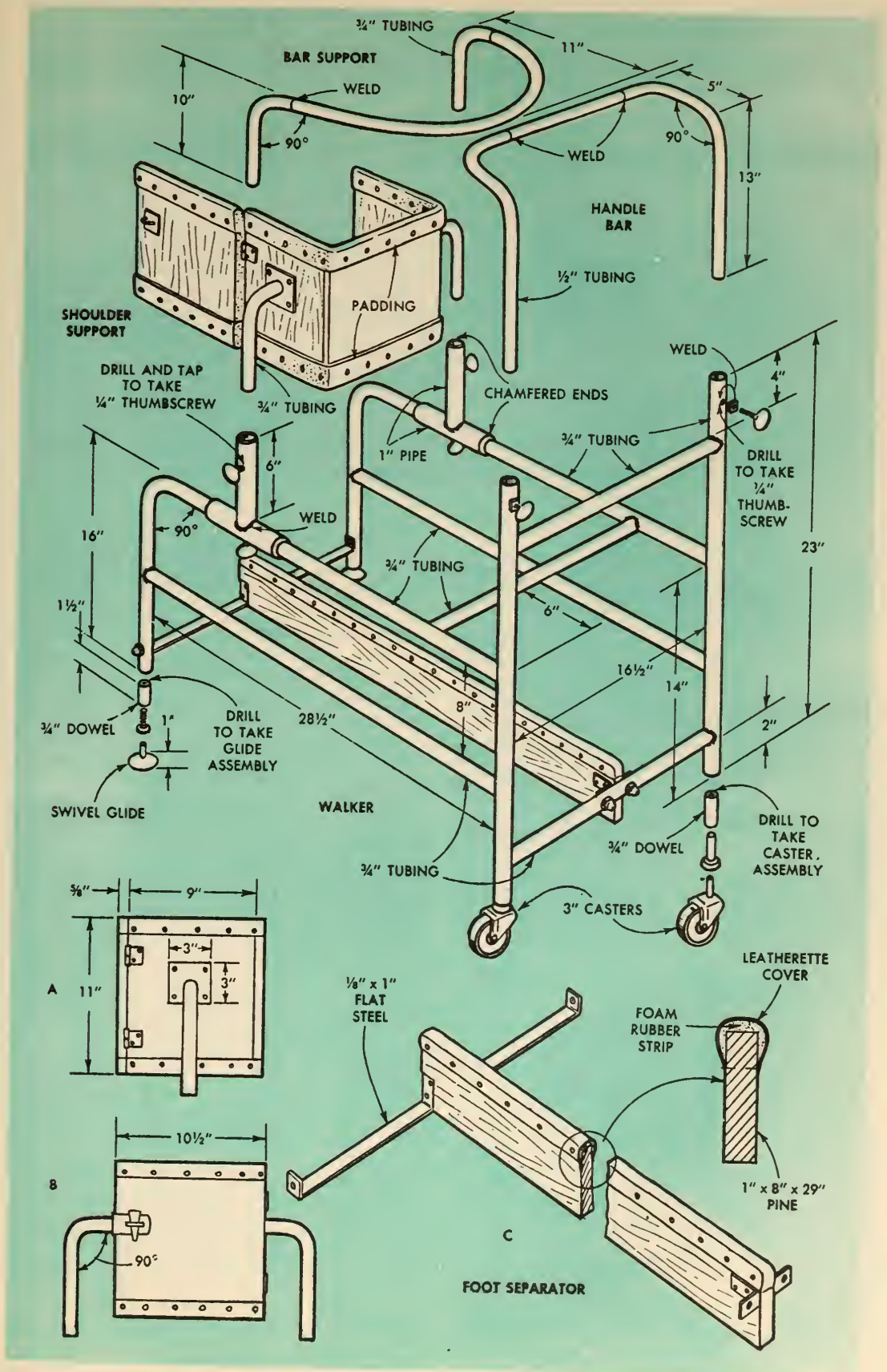
HERE is an easily constructed orthopedic walker that is designed to help restore the use of muscles of the lower body of a child who is recovering from polio, or is a cerebral palsy or muscular dystrophy victim, by helping him exercise with little or no assistance. Used at the University of Illinois Division of Services for Crippled Children, the walker consists of a base unit of welded-steel tubing and four accessories, the shoulder support, bar support, foot separator and handle bar. The former three are adjustable vertically so that they can be raised as the child grows, providing proper support at all times.

The shoulder support is designed to completely enclose the trunk of the body to provide maximum support and stability in the beginning stages of rehabilitation. The dimensions given in the drawing and details A and B are suitable for a child of four or five of average size and can be changed as required. Padded edges protect the child from bruises and provide comfortable underarm support. The bar support is used in place of the shoulder support after the child has partially regained the use of leg muscles and requires more freedom for further development. When first making the change-over, a strap should be secured between the two verticals of the support as shown in the illustration on this page, to give the child a feeling of security and to provide some means of support in case of accidental loss of balance. Thumbscrews on the T-members that take the verticals of the shoulder and bar supports permit horizontal as well as vertical positioning of these members for maximum comfort as shown in the drawing and details.

The foot separator is used for a child whose legs tend to cross. It is made of 1 x 8-in. pine, with steel brackets screwed to both ends of it for bolting the device to the walker as shown in the drawing and detail C. A strip of foam rubber folded over the upper edge of the separator protects the child's legs from bruises. The rubber is held in place by a strip of leatherette fitted over it and tacked to the sides of the separator.

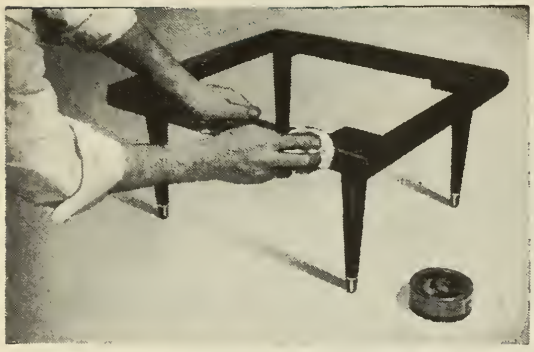
To permit the patient to move the walker across a smooth floor with ease yet require some exertion to develop muscles, the front legs are mounted on 3-in. casters and the rear ones are fitted with swivel glides. These are installed in the open ends of the tubing by first gluing a short length of dowel in each of the legs. Then the dowels are drilled to take the glide and caster assemblies as indicated in the details.

Use a ¾-in. thin-wall-conduit bender for making the right-angle bends in the tubing as required in each of the assemblies. If a welder is not available, take the assemblies to a welding shop to have this work done. Added wall thickness to the conduit is provided for the thumbscrews by welding nuts over holes in the pipe. Nuts are not needed for the 1-in. pipe. ★ ★ ★


¾" TUBING
BAR SUPPORT
WELD
10"
90°
11"
5"
90°
WELD
13"
HANDLE BAR
½" TUBING
PADDING
SHOULDER SUPPORT
DRILL AND TAP TO TAKE ¼" THUMBSCREW
¾" TUBING
CHAMFERED ENDS
WELD
4"
¾" TUBING
1" PIPE
DRILL TO TAKE ¼" THUMB-SCREW
6"
WELD
90°
16"
23"
¾" TUBING
1½"
6"
16½"
14"
¾" DOWEL
1"
DRILL TO TAKE GLIDE ASSEMBLY
28½"
8"
2"
SWIVEL GLIDE
WALKER
DRILL TO TAKE CASTER ASSEMBLY
¾" DOWEL
¾" TUBING
3" CASTERS
⅝"
9"
3"
3"
A
11"
LEATHERETTE COVER
⅛" x 1" FLAT STEEL
FOAM RUBBER STRIP
10½"
B
90°
1" x 8" x 29" PINE
C
FOOT SEPARATOR

SECTIONAL OTTOMANS

By Ronald L. Anderson



STYLED WITH A LOOK of the popular "Danish contemporary," these sectional ottomans combine their beauty with low cost and versatile utility. They can be grouped for best viewing of TV by the youngsters, then moved out of the way when not in use. At parties they simply are picked up and located where a guest wishes to sit. Their light weight will be appreciated especially by a housewife when she moves them around while cleaning. Despite their smooth, modern appearance, stock-milled lumber is used for the frames of these ottomans, and the legs are purchased ready-made. If you have some cushions left from a discarded sofa, they will cost you nothing, but even when it is necessary to buy the cushions, the finished cost of the units will be only a fraction of what they would cost if purchased. Foam-rubber cushions in many sizes are available, and can be covered with slipcovers that are fitted with zippers to permit easy removal for washing or cleaning.

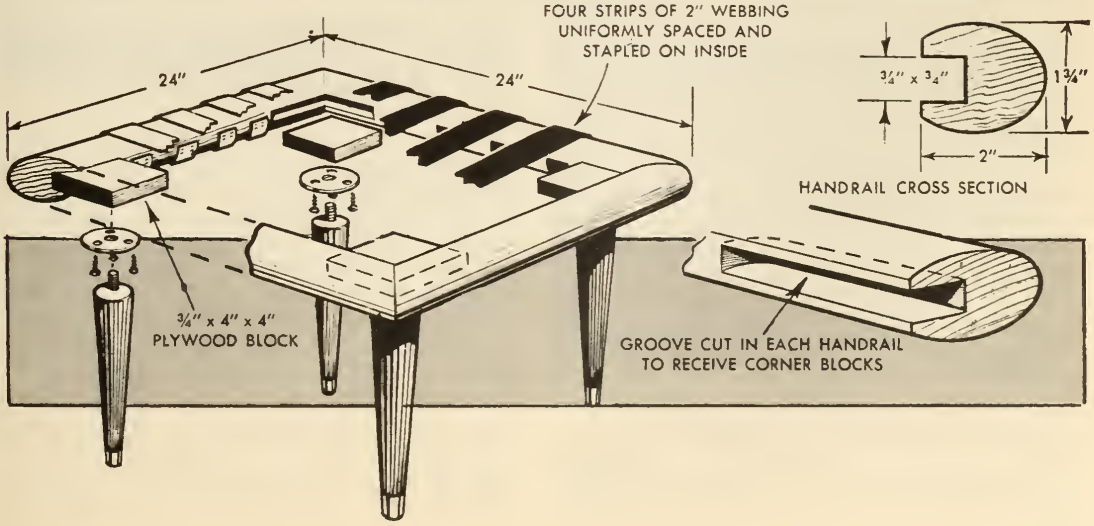
The frame for each ottoman is made from handrail stock, ordinarily used for just that purpose by builders. One side of the stock is flat, which makes it simple to align and cut the mitered corners. The flat side also fits firmly against the table of a saw for cutting the 5-in.-long grooves in the ends of each frame member. Plywood

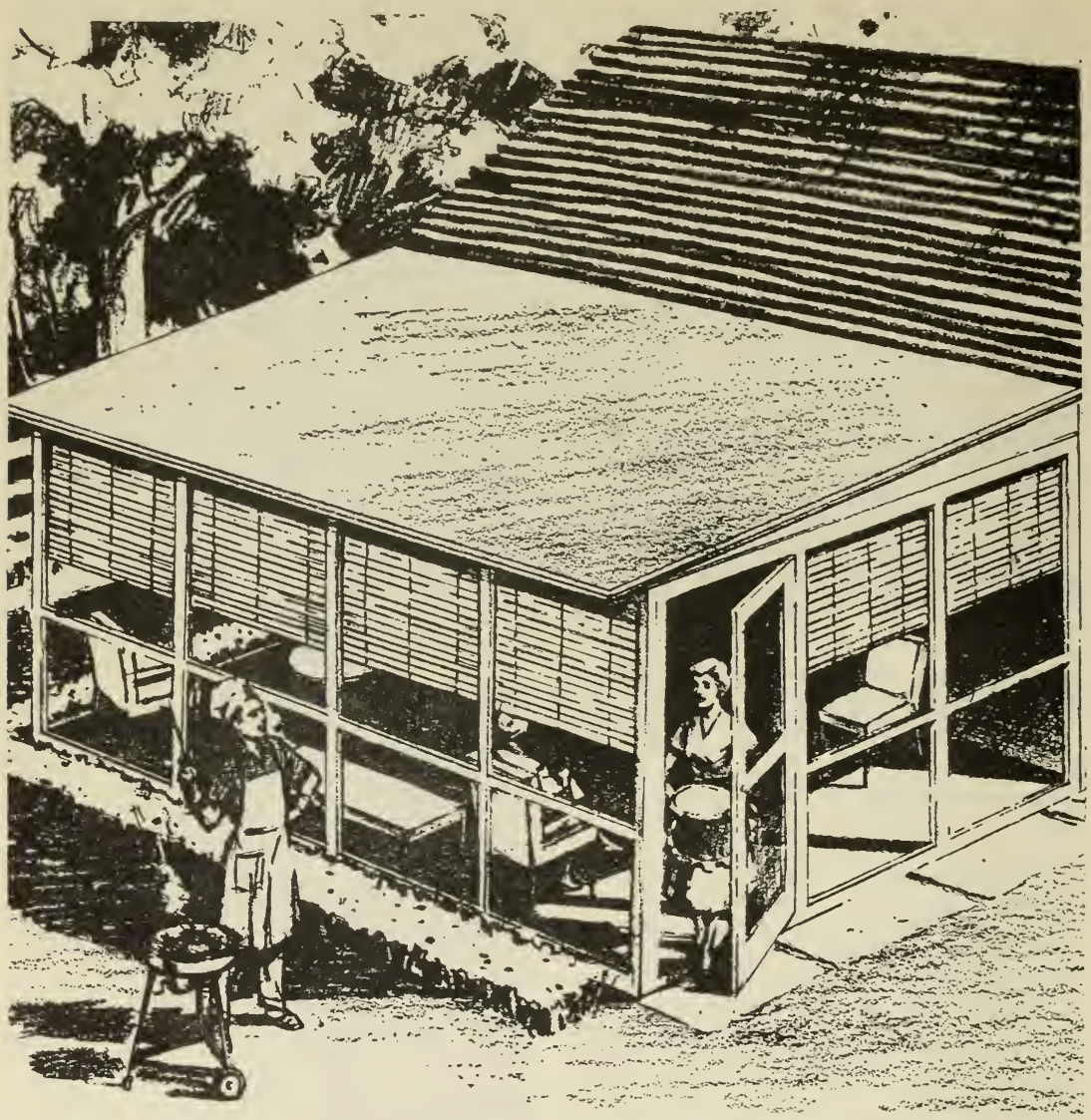
corner blocks are fitted in these grooves as shown in the detail, and glued in place. Inside dimensions of an ottoman frame should be the same as the dimensions of the cushion used. This permits the cushion to be positioned by the frame edges when the supporting webbing sags slightly under the weight of a person. Double check the sizes of sofa cushions, some are longer than they are wide.

After each frame has been glued, assembled and squared, let it stand until the glue has dried thoroughly. Any imperfections in the mitered joints now are filled with wood putty. Next, metal leg brackets are screwed to the corner blocks. Keep brackets as close to the frame members as possible, to increase the strength of the finished assembly. Now sand the frame and legs and stain to suit. In the matter of staining: Handrail is available in either oak or white pine. If a light oak finish is preferred for both legs and frame of the ottomans, use oak legs and oak handrail. For walnut, mahogany, cherry or any darker finish, white-pine handrail can be used, along with less expensive gumwood legs. The length of the legs is up to the individual builder. On the original ottomans, legs 10 in. long were used.

After the stain is well set, apply a coat of shellac that is sanded lightly when dry. Finally, apply paste wax. The final step in construction of the ottomans is to staple or tack cloth or plastic webbing to the frames. This webbing is available at most department stores, upholstery shops and mail-order houses. About 8 yd. of webbing will be required for each frame, this length allowing a little extra for doubling the ends of the webbing where it is tacked or stapled. Draw the webbing as tightly as possible, using a stretcher because it will sag slightly in use. ★ ★ ★

Above, three of the ottoman units grouped together. Below, a single unit, showing its neat construction





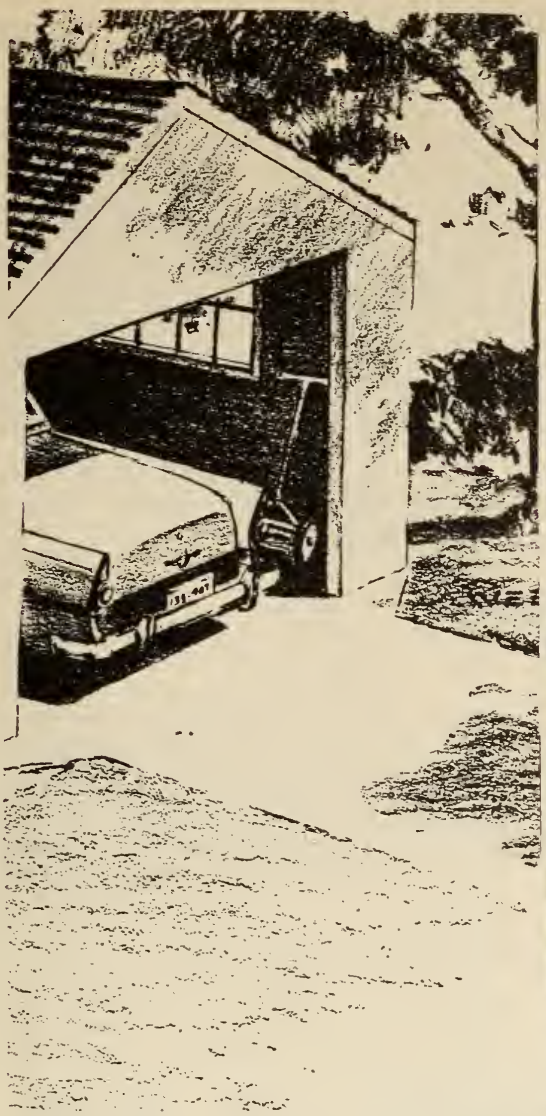
ADAPT YOUR GARAGE FOR SUMMER

REMEMBER WHEN every home had a front porch? Such dated porches are gradually giving way to a new trend in living—outdoor living. The old-fashioned porch has been taken off the front of the house, so to speak, and hitched to the garage where, in the privacy of the back yard, summer entertaining and dining can be enjoyed by the entire family.

This exodus to the back yard is a natural one, stemming from the popularity of barbecue cookouts, and the need for shelter and protection from insects has resulted in a screened lean-to, a sort of covered patio, hitched to the side of the garage.

You can buy a garage today with a screened enclosure built right in it, half being devoted to car space and the other to summer living. But if you have the yard space, one of these popular screened patios can be attached to your present garage in the form of a simple lean-to structure and screened on three sides. Such an enclosure need not be too difficult or costly to build as the garage already provides one side.

Fig. 1 details an enclosure in its simplest



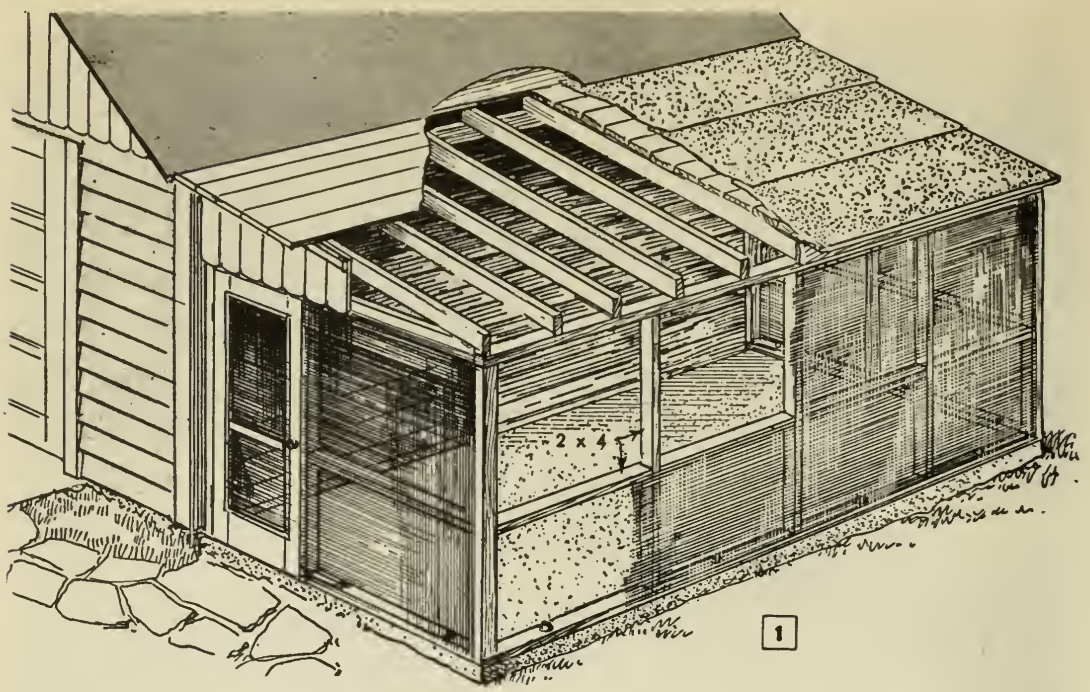
Popular in new garage design is this one which devotes a portion of a conventional two-car model to include a screened enclosure with a door at the end. Entrance to some is gained through the garage itself

Similar in treatment, the screened-porch area in this garage also has been fitted with window sash to make the space usable the year 'round for storage. Note how lower part has been boxed-in with siding

LIVING

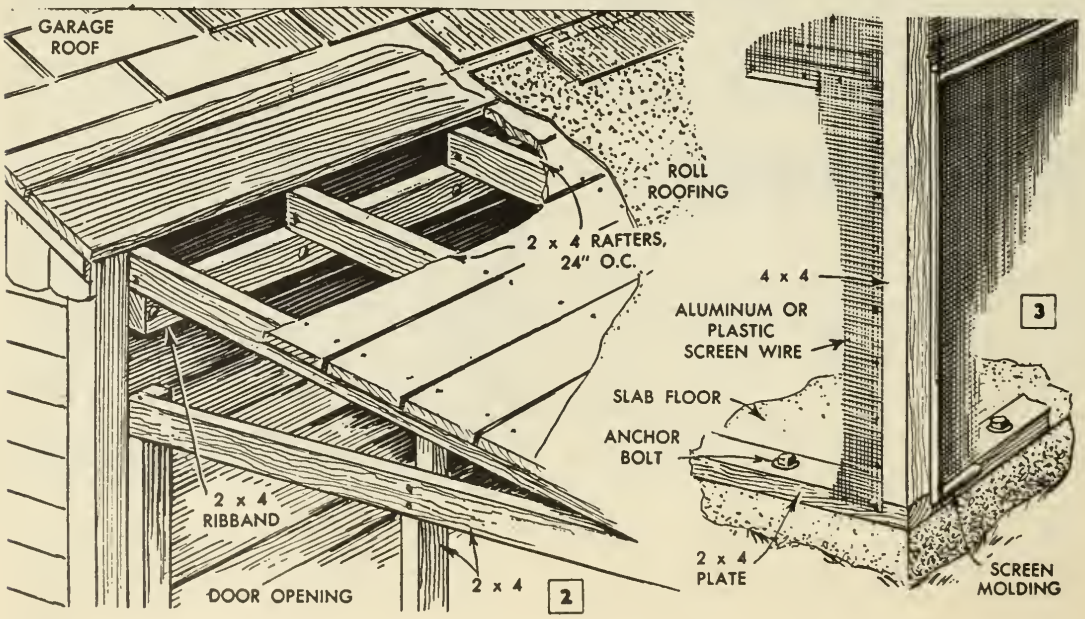
form in which the screen wire is tacked directly to the framing members rather than to separate removable frames. The latter may still be preferred by some, but with the new plastic screening, and other nonrusting kinds, the wire will last indefinitely even if left exposed the year 'round. For obvious reasons, it is advisable to erect the framing over a slab floor rather than a wooden one. This can be from 8 to 10 ft. wide, depending upon yard space, and the length of the garage. Dig down about 18 in. around the outside to assure a good footing for the 4-in. slab. Readymix concrete

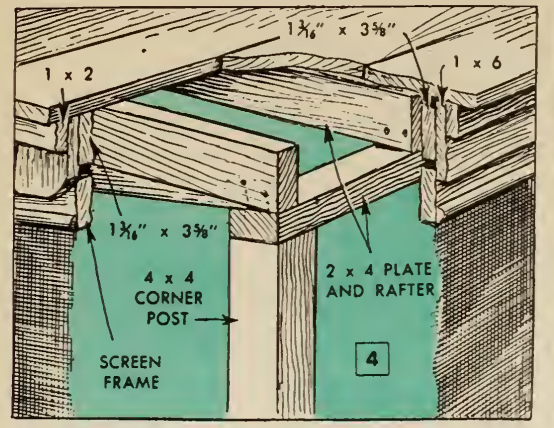
The garage itself can be converted to an extra summer room by leaving the car parked outside, rolling up the overhead door and fitting the opening with removable screens. Screens are so fitted as to allow door to be lowered in the event of driving rain



simplifies this part of the job to the point where the homeowner can pour the slab himself, or this part can be left to the professional. In either case, ½-in. anchor bolts, 10 in. long, should be embedded in the concrete along the outside, 1¾ in. in from the edge to anchor the framing.

How the rafters are attached to the garage is an individual problem, dependent upon the amount of garage-roof overhang. If there is little or none,the rafters can be supported by a 2 x 4 ribband, a ledger strip, as shown in Fig. 2. Here, as you can see, the 2 x 4 is lag-screwed to the garage wall and into the wall studs. Where the overhang is 12 in. or more, the 2 x 4 rafters can be tied to the garage rafters by nailing securely to the faces of the extending members. The roof should have some pitch rather than be perfectly flat, 2 in. of rise in each foot of run being adequate. Avoid sloping it too much, otherwise you'll have low headroom at the outside. The slope of the roof governs the height of the wall studs and corner posts. These rest on a 2 x 4 plate which is bolted to the slab around the edge on three sides. The corner posts are 4 x 4s and the intermediate ones are 2 x 4s,





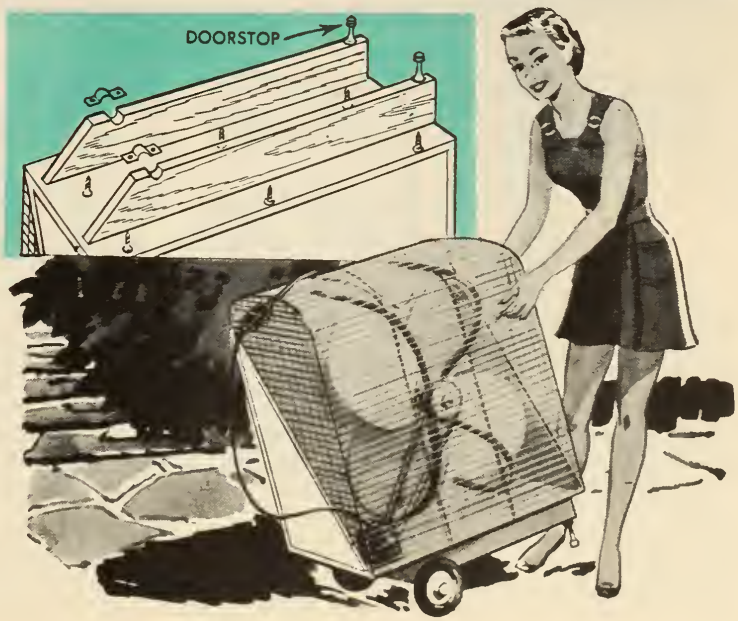
Typical lean-to structure added to side of garage. Wide full-length screens admit maximum air. Stone fireplace at end makes cookouts highly convenient

toenailed to the plate at the bottom and to a similar plate at the top. Crossrails, 24 in. up, are used to brace the 2 x 4 studs. The doorway is framed in the manner shown in Fig. 2.

The 2 x 4 rafters are placed 24 in. o.c. and then decked over with 1 x 6 roof boards. Since it is not practical to apply asphalt shingles to a roof with so little pitch, the roof should be covered with regular roll-type roofing, sealing the lapped edges with cement and working it up under the shingles on the garage. The screen wire is applied horizontally, lapping it on the crossrails and covering the edges with common screen mold, Fig. 3. This, of course, should be done after painting the framing with two coats of house paint. Where separate screens are preferred, Fig. 4 shows how a track can be formed for the screens at the top, using a 1 x 2, a 1 x 6 and a 1 3/16-in. member in the order shown. Here the screens go around the corner posts and, where they center on the intermediate posts, battens are provided to cover the joints at the butting edges. At the corners, the screen frames lap the edges of the adjacent ones and are fastened with three or four screws, top to bottom. ★ ★ ★

"Running Gear" Makes House Fan Portable for Outdoor Use

There will be no smoke from the barbecue in anyone's eyes, and mosquitoes will have to be strong fliers to get close to guests in your back yard if a big cooling fan is used. The fan is the large type used to cool a whole house, and ordinarily not considered portable. Attaching a simple "running gear" to the bottom of the fan, as indicated, makes it completely portable. Two wagon wheels and an axle are fitted to two notched wooden members bolted to the fan. Leveling devices on the opposite ends of the members are doorstops.—Ed Packer, Pompano Beach, Fla.



REDWOOD LANAI PATIO SHELTER

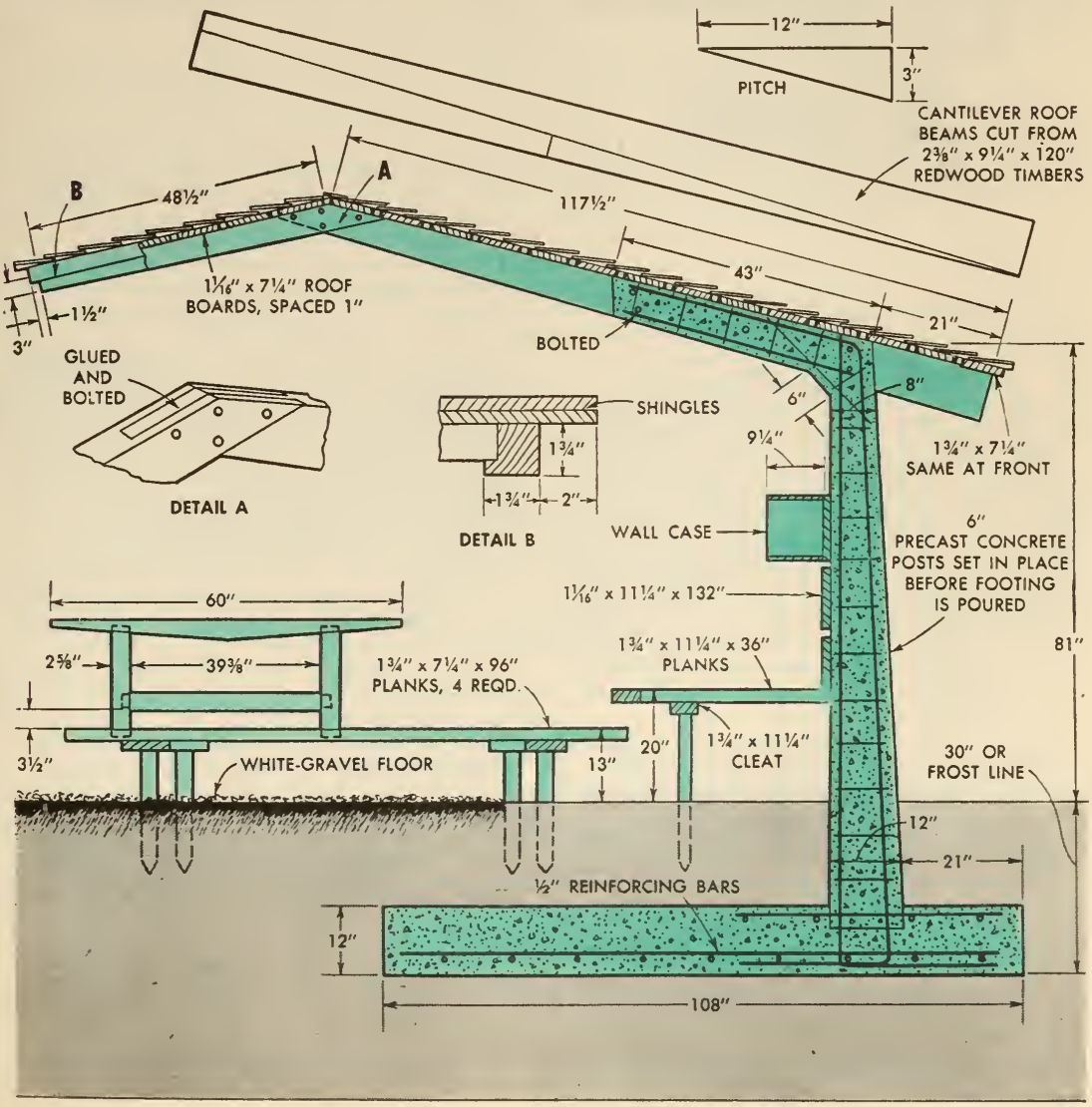
Western outdoor living becomes a way of life that can be enjoyed a good part of the year with the redwood lanai (above), designed and built by George Nakashima, renowned woodworker, for the Simpson Redwood Co. Its unique cantilever design captures the casualness of the West and reflects the Orient to make it especially appealing in a rustic, wooded setting. A detailed plan for building this patio shelter is available for the asking from the Simpson Redwood Co.

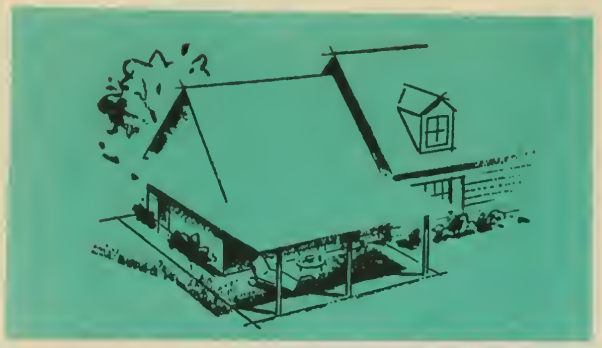
Construction of this free-standing structure features two precast piers of reinforced concrete which support an arched cantilever roof. The sectional elevation drawing on the opposite page shows how the piers are solidly anchored in a reinforced slab footing measuring 9 ft. square. The roof beams are bolted securely to the piers, then covered with roof boards and wooden shingles. The overhanging roof affords shade and weather protection to a gravel-covered patio free of additional posts. The redwood is left unpainted so that the nat-

ural warm, russet color of the wood, in time, changes to a soft driftwood gray. A windbreak is provided by bolting three wide boards to the concrete piers. The resulting wall is used to support a shelf and utensils, as well as a low worktable for the family chef. The combination table-and-bench lifts off its stake legs for storage.

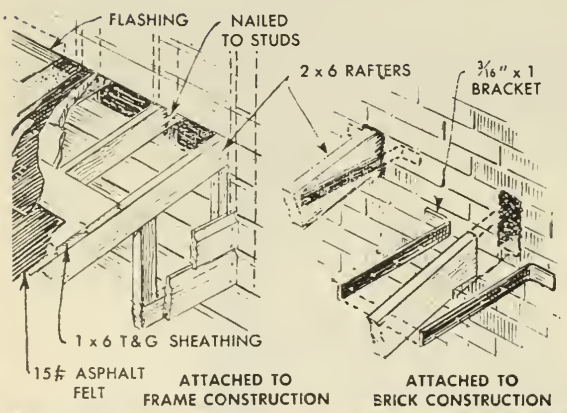
Your home may lend itself to an attached patio. If it does, there are several lightweight materials especially suitable for decking it. One is Diamond-Rib aluminum. An embossed, corrugated panel, it comes 48 in. wide and from 6 to 16 ft. long, and because of a special rain-channel crimp, the overlapping sheets cannot leak. Colorful panels of glass fiber, such as Filon and Corrulux, are other materials. Being translucent, they are ideal for patio roofs since they transmit soft diffused light and glare-free shade.

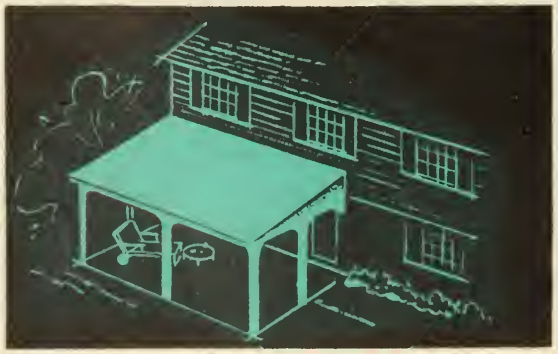
Table is designed so it serves the dual purpose of a table and seat. Natural-color rattan pillows are the "chairs." Table top rests on stake legs so it can be lifted off and carried inside for the winter





Attach a SHELTERED PATIO to your HOME





FOR THE COST, a patio attached to your home will add more to the value and do more toward your enjoyment of living outdoors than anything. It will provide a comfortable spot on hot days, protection against showers, and can be screened against insects, or glazed for cool days.

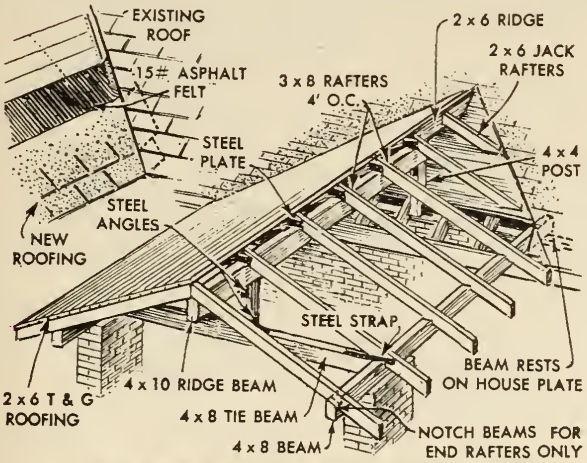
While actual construction of a roofed patio is relatively simple, it is not a matter of building a porch onto your home. It must be designed and located to blend with the architecture of the home. On this and the following two pages several designs of patios are shown. Notice how they blend with the architecture of the houses to which they are attached. Therefore, when planning your patio be sure its design is suitable for your particular home. Step back a couple of hundred feet from the house and try to visualize the appearance of the patio you plan. Will it complement your home, or will it detract from the appearance? A poorly integrated addition can actually decrease the value, whereas a suitable addition often will add much more than its cost to the value of a home.

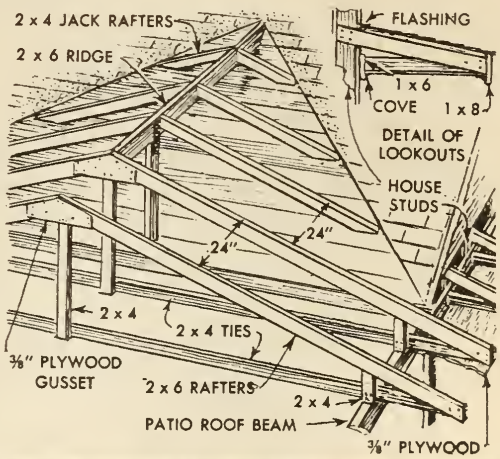
Notice in the sketches on these pages how the architect has made the patios compliment the buildings and become part of them. In the sketch of the Cape Cod house above, running the patio roof around the end of the house does the trick. Had the roof stopped at the eaves, the appearance would not have been so effective.

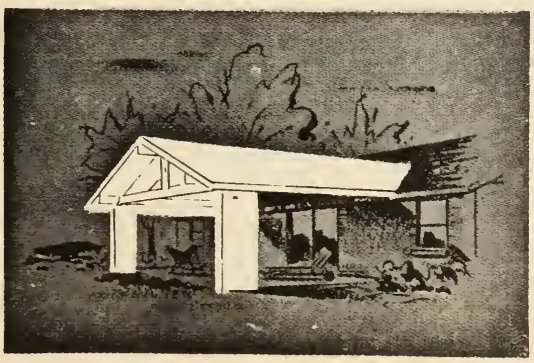
Simple shed-roof patios such as shown at the left, will be enhanced by adding an arch fascia and matching the siding to that of the existing house. The details show how to frame the roof into the side of the house for either brick or frame construction.

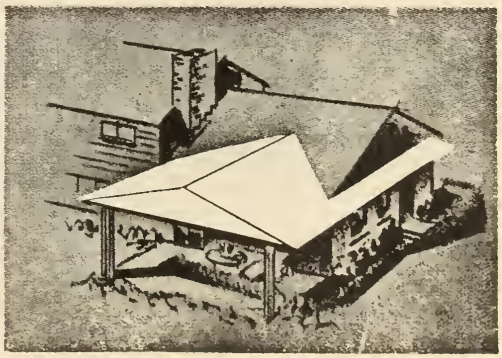
A gable patio roof with open end and exposed rafters, such as the one above, will blend with almost any house having a gable roof. Such a patio will give a decidedly modern flair to your home. Use large brick columns for a brick home, and large framed columns covered with siding for a home of frame construction. Details below left show roof construction.

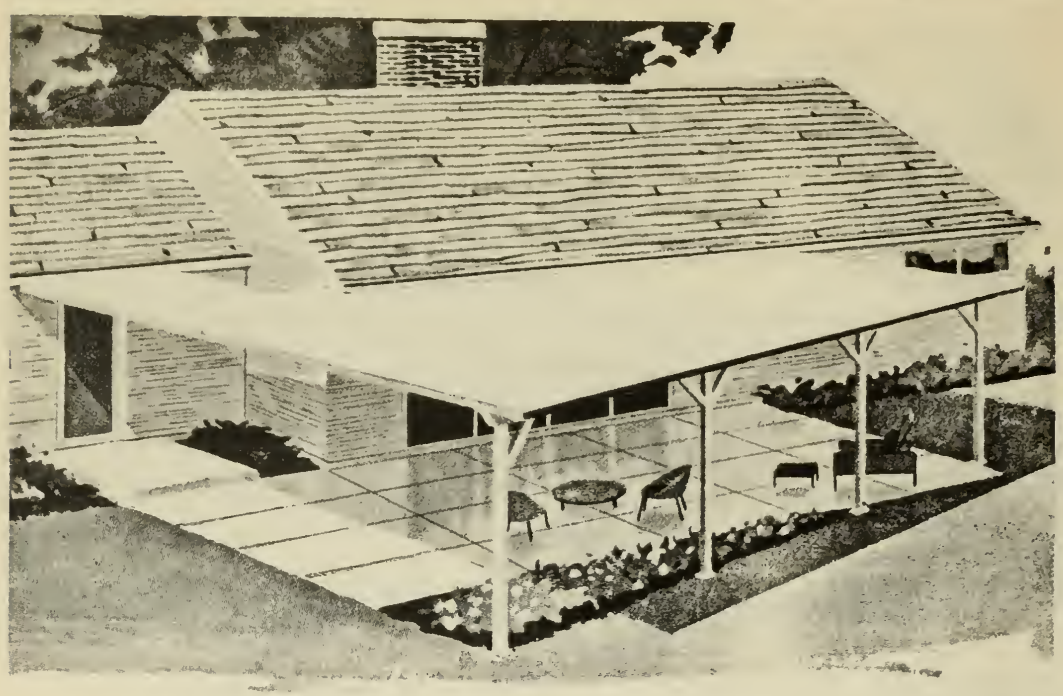
In the lower right sketch notice how the lines of the gable-end patio roof are carried across the end of the house. This treatment avoids the appearance of a lean-to type of addition and helps blend the patio roof into





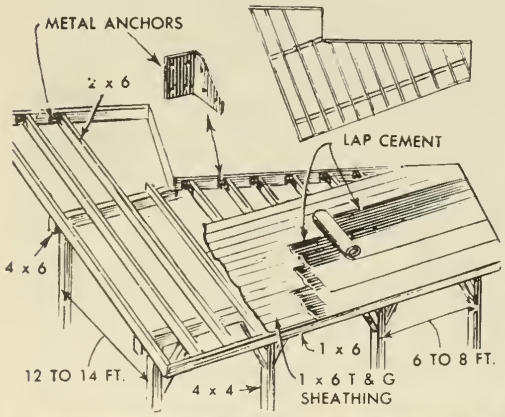


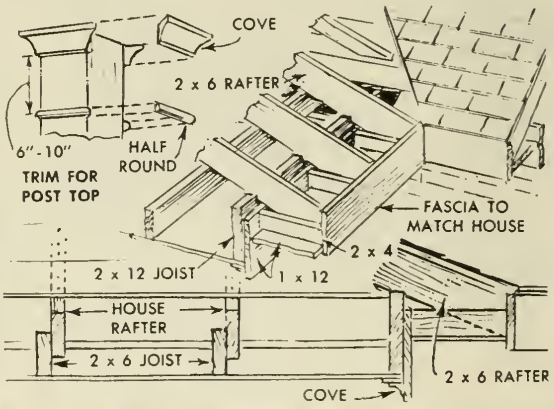




a house of this shape. Notice in the details how lookouts are constructed to support the roof along the end of the building.

For a ranch-house patio where a matching roof is not practical, build a flat roof that compliments the building by performing some extra functional task, such as covering a walk as shown above and the lower left-hand detail. A Georgian home with its formal appearance suggests two solutions; stately columns with a roof matching that of the house, below right, or a flat roof. If a flat roof is used, add a roof-top railing to complete the picture.



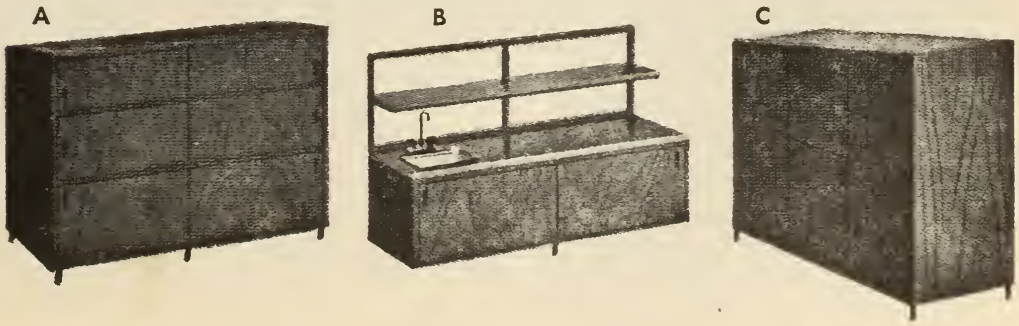


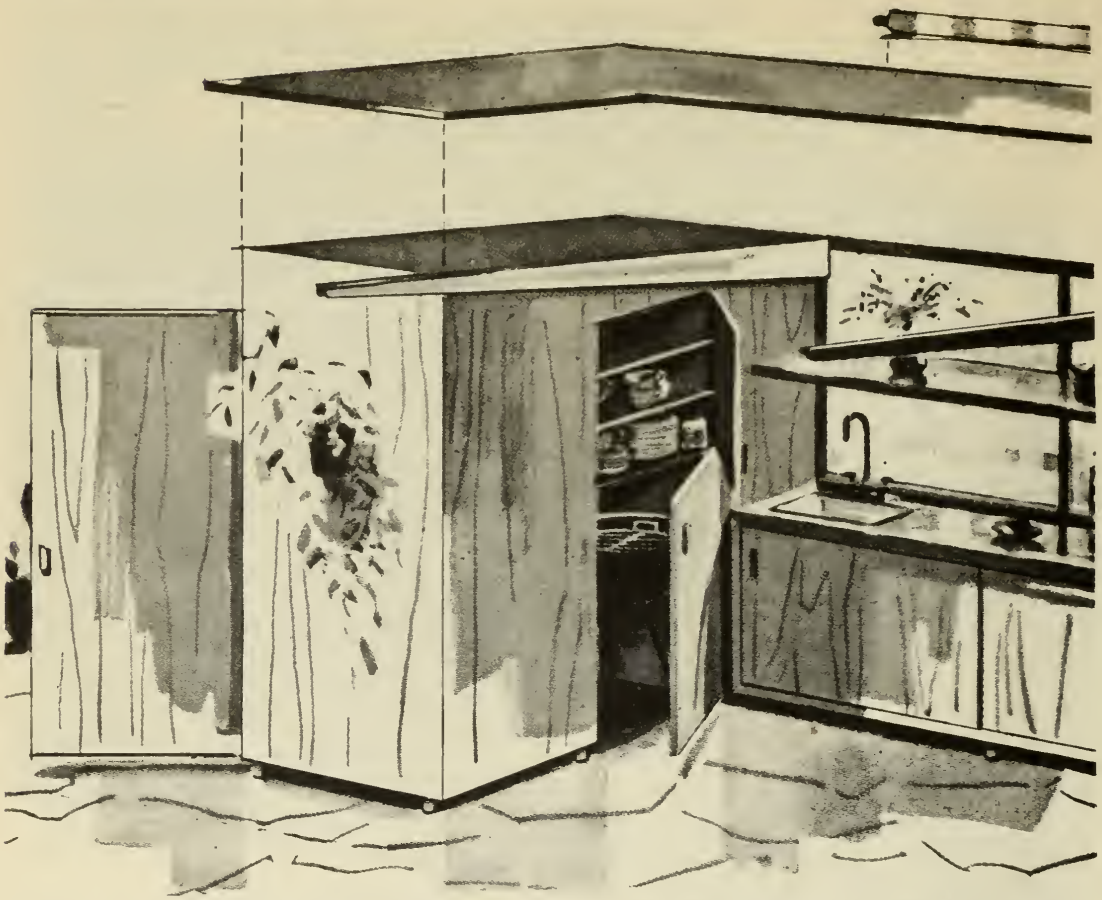
OUTDOOR STORAGE WALL

WHERE A HOUSE or yard doesn't lend itself too well to an attached patio, a free-standing one in the form of a "living wall" may be the answer to your outdoor way of life. A veritable oasis in your back yard, this outdoor storage wall contains everything—including the kitchen sink.

For your cookouts, it provides an attractive and sheltered barbecue center, complete with cooking and dishwashing facilities. As an entertainment center, it houses a portable TV and hi-fi unit for your loafing pleasure. It has a place to keep outdoor game equipment, all within easy reach. It contains ample storage for your garden truck, everything from potting supplies to the power mower. And the beauty about the whole thing is that when you are through entertaining or loafing family-style, the mess can be chucked away right on the spot with little or no effort. There is even a cubby-hole for a folding table and chair set to save carting it inside.

Whatever the shape of your yard, this adaptable wall will fit in because it is composed of three separate sections, A, B and C, which can be arranged and nested to-

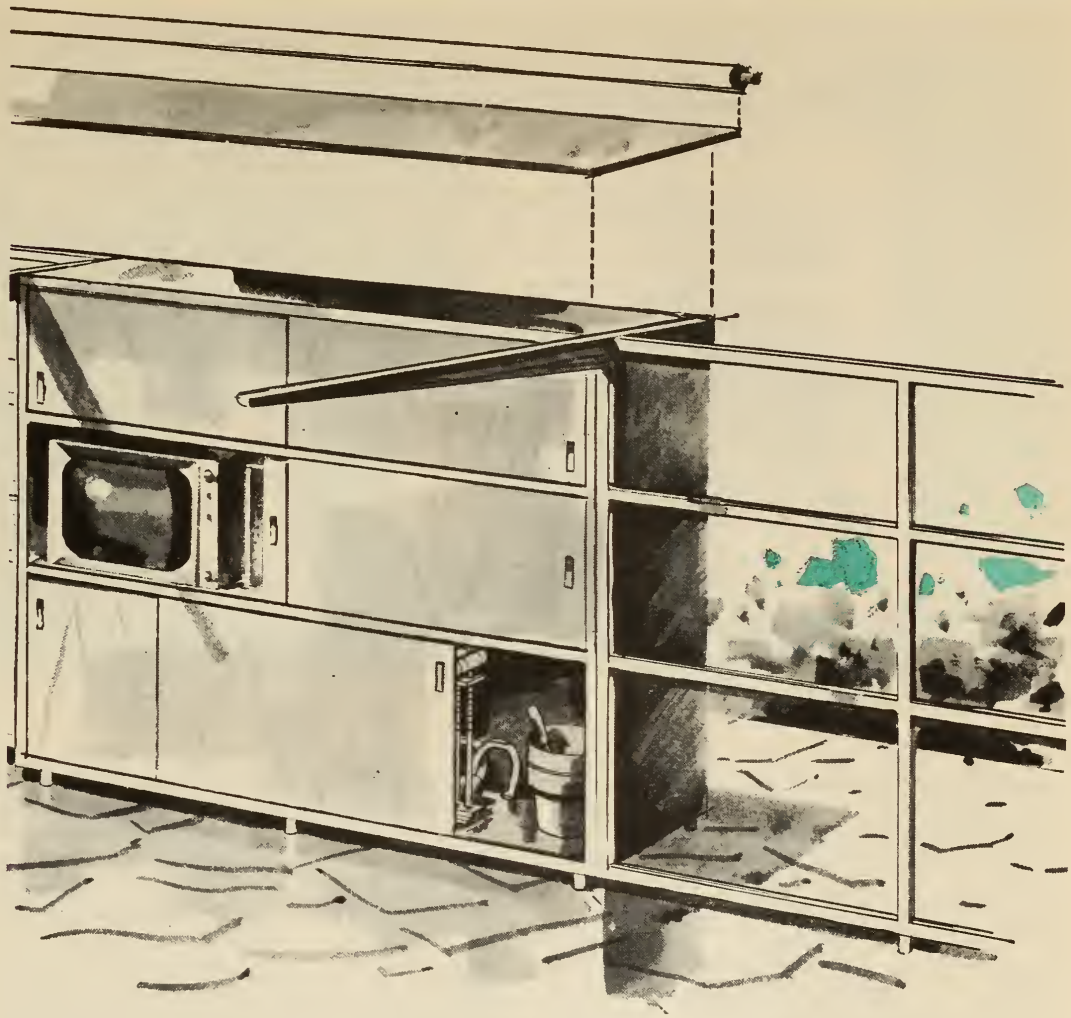




gether as desired. For a limited budget this year, one section could be built now, the others later. All three, with one or two of the 8-ft. screen sections shown, will give you a luxurious outdoor room.

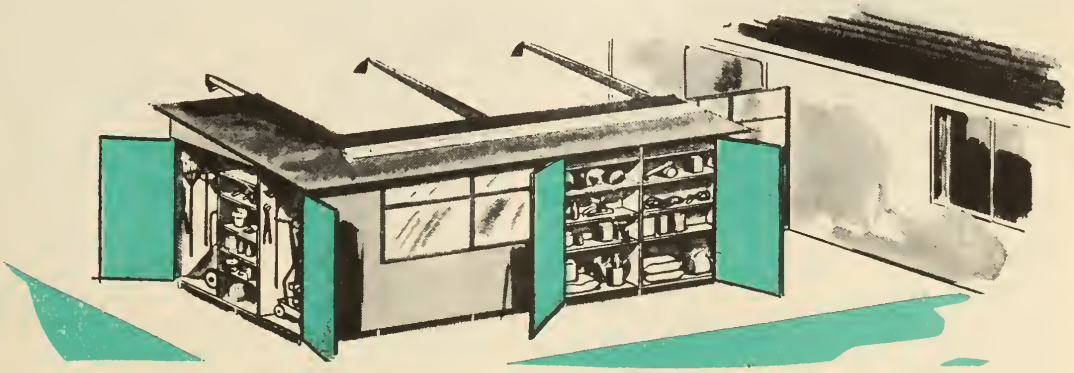
Section A is the entertainment center. Its six sliding doors on the front side open into deep cabinets for games, the TV, etc. Its 8-ft. width allows good acoustics for the two speakers of a portable stereo set kept inside the cabinet. In back, two large hinged doors open to other shelves—generous storage for garden and lawn supplies, paints, etc. Section B is basically a kitchen-sink cabinet designed for outdoor usage. You can store a large folding barbecue table and its chairs inside this open cabinet. Its back is a screen matching the other screen sections. Section C gives a dish cabinet above and another below on the front side for storing a movable charcoal grill. On the rear side it stores your bulky garden tools—lawnmower, rakes, shovels, etc. There, at the middle, it also has a compact work counter and shelves for small garden tools.

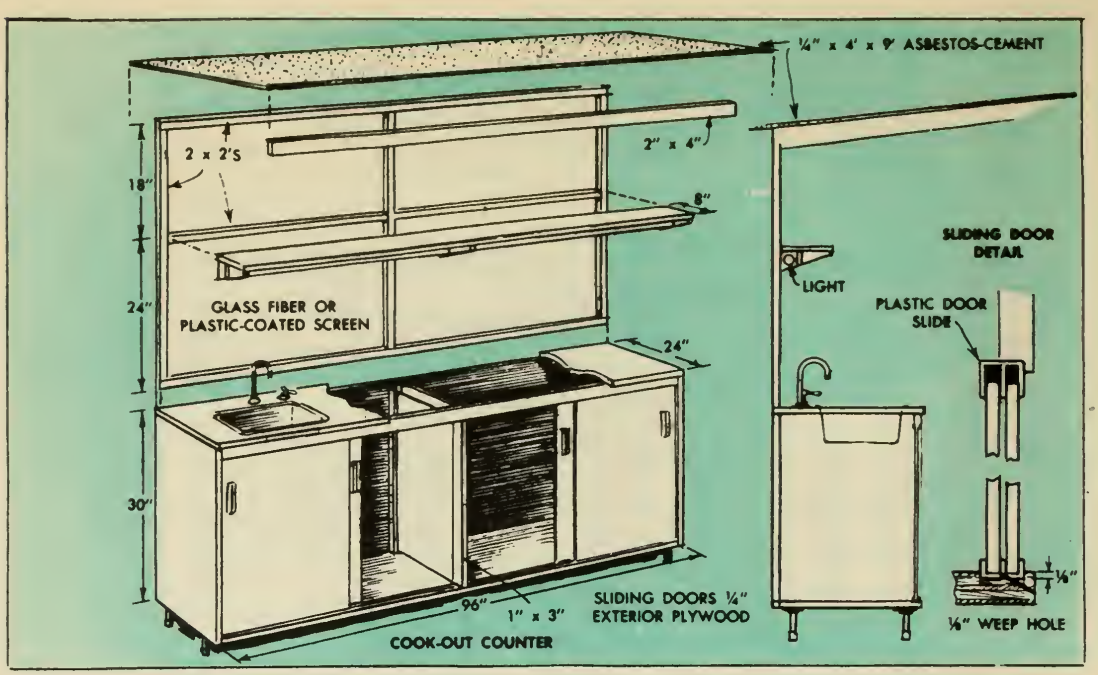
All three sections are roofed with flat asbestos-cement board, a simple and per-



manent roofing for the design. To shelter the dining-entertainment area from sun or rain, any lightweight patio roofing material can be laid over the tapered roof beams—canvas, glass-fiber panels, lath, reed fencing or the like. A roll-up canvas canopy is another possibility. It gives you adjustable shade overhead and can roll back on the roofs of A and B sections when not needed. If you are using glass fiber, the roofs of the three sections can be of the same material. The three sections, and any matching screen sections, rest on short pipe legs to be above wet and snow. Thus, they also can be placed over anything from bare earth to a concrete slab. The 5-in. height is enough to allow using a hose or push broom underneath.

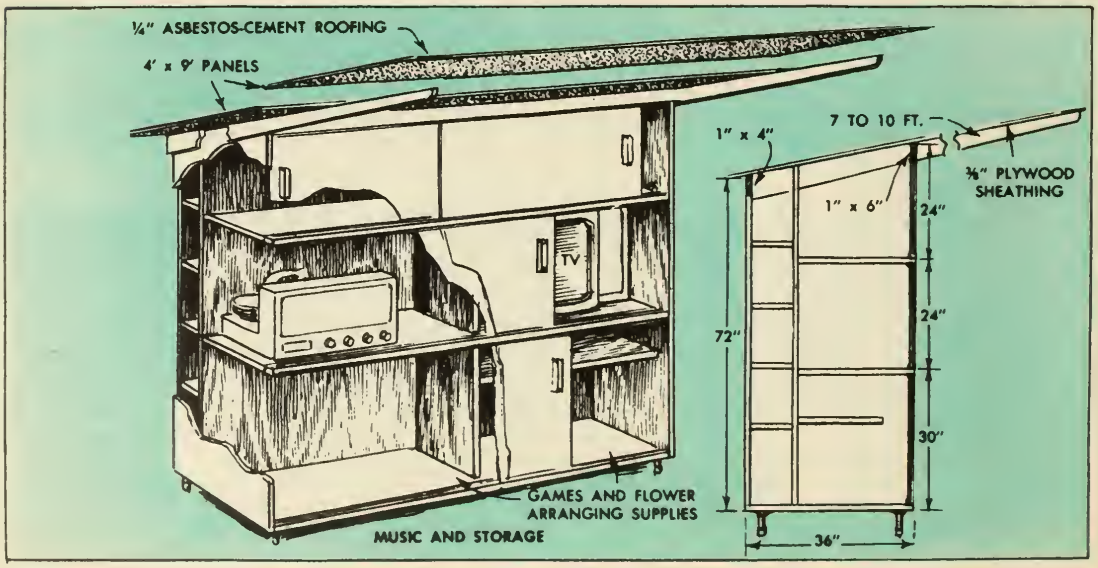
Cabinets as shown are built of ¾-in. fir exterior plywood — the floor, sides, partitions, shelves, hinged doors. This gives the easiest construction as no framing is re-

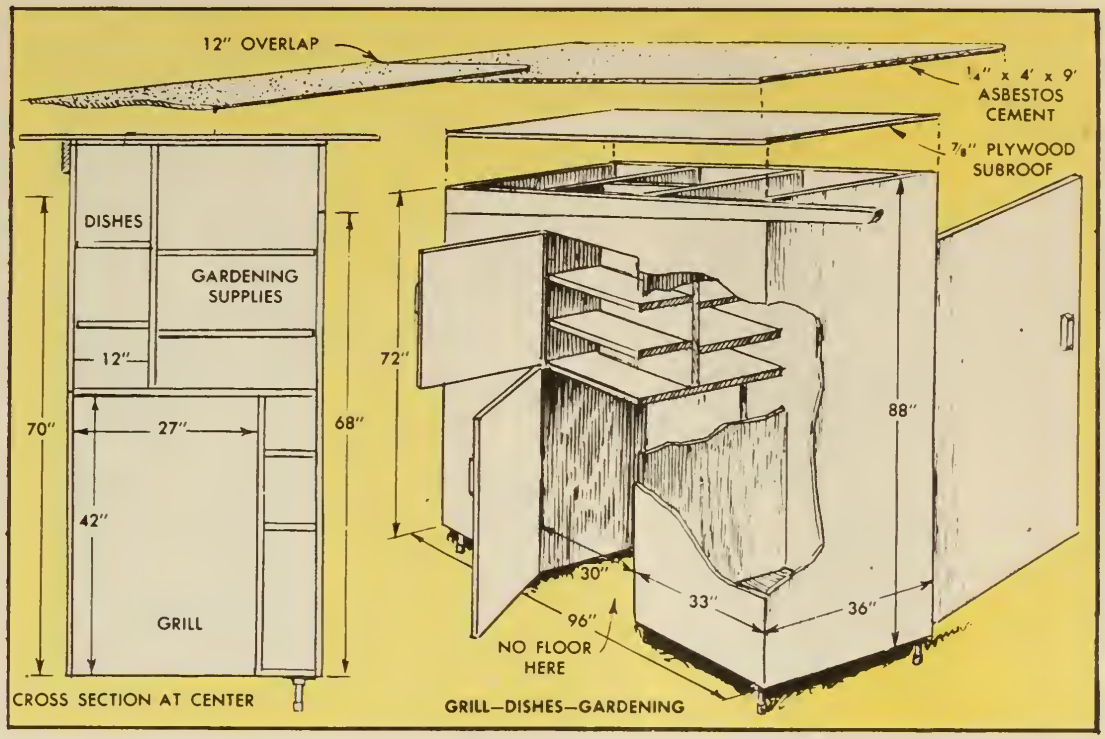




quired but, if desired, you can frame with 2 x 2s and use a board siding to exactly match that of your house. First, attach the plywood floor to the pipe legs, then attach sides and partitions, using a waterproof glue and galvanized nails. Note that the floor of section C is cut out at the grill cabinet so a wheeled barbecue grill can simply roll inside. Dimensions given will store the average 24-in. round charcoal grill complete with hood. You can vary the size of this cabinet to accommodate other grills.

All three sections can be completed up to the roof and then be moved and nested together. Or A and C can be built in place and B then built to fit between. Note that the pipe legs shown have pipe couplings at the bottom. On a fairly smooth concrete patio you can simply set the cabinet sections on the concrete floor, then level them over small irregularities by screwing the couplings up or down on the pipe with a



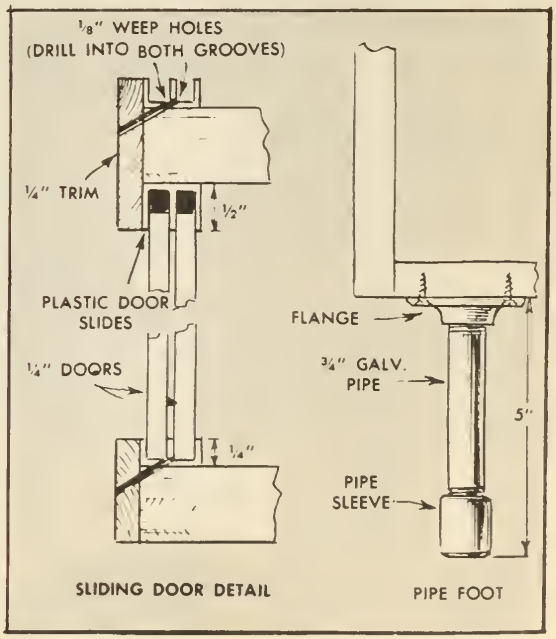


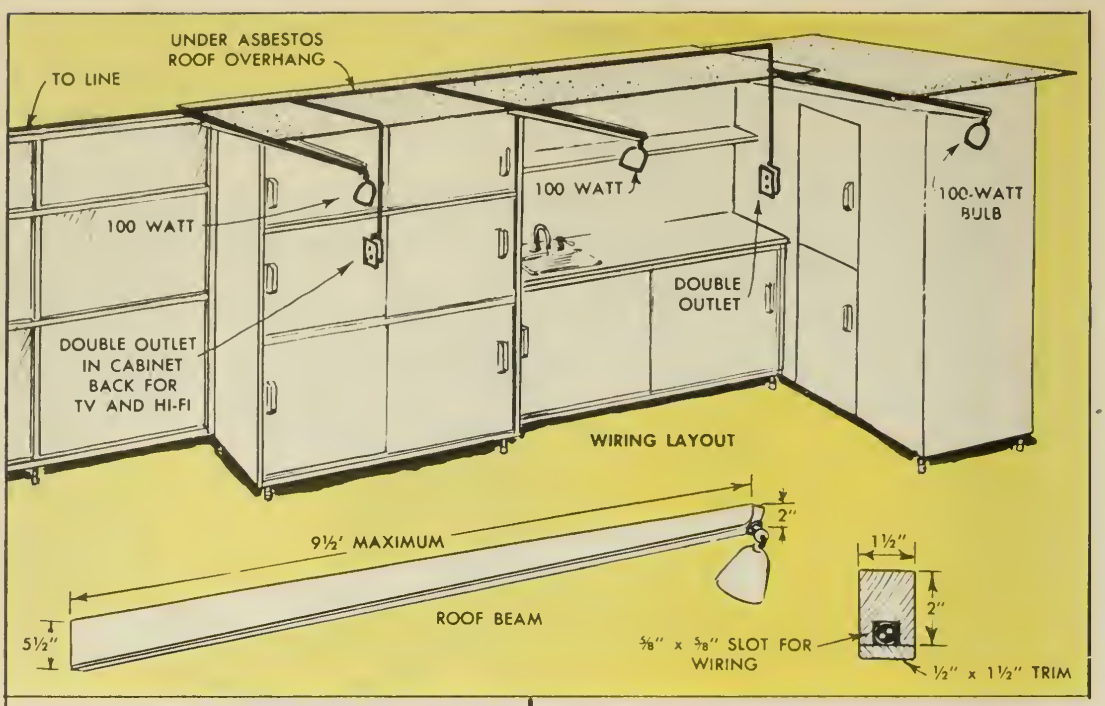
wrench. On rougher or softer floors, set longer pipes in concrete in the ground with their tops leveled. Section B needs only two legs at the middle, since it is supported at its ends by screws into A and C.

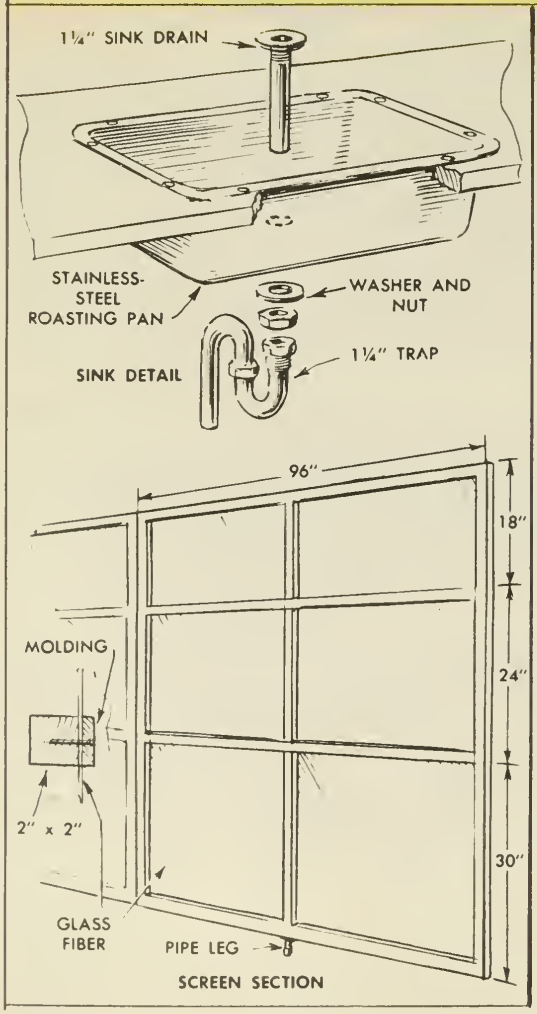
The details show a simple way to weatherproof the sliding doors of A and B. Set the lower plastic slide in mastic and, after installing the trim, drill an ⅛-in. weep hole every 12-in. along its length to drain off rainwater. The doors can be ¼-in. plywood or hardboard; a pair should lap each other at least 4 in. Hinged doors of ¾-in. plywood are used elsewhere. Those on the rear side of the wall can be 3 to 3½-ft. wide; at least three hinges should support each. Paint all doors, hinged and sliding, on both sides to prevent warping.

Sections A and C have ⅜-in. plywood sub-roofs or roof sheathing. When the cabinets are permanently in place, a 4x9-ft. panel of asbestos-cement board is laid over each section, giving a one-piece roof with a 6-in. overhang on all sides. A third 4x9-ft. panel of the asbestos-cement board is laid over section B. Supported lengthwise by the screen frame and the 2x4 front beam, it overlaps the other roofs 12 in. at each end. Use seam compound where the panels lap. Secure the asbestos-cement board with large-head roofing nails using only about eight through each panel, and placing a spot of seam compound under each nail when driving it down. When all three cabinets are to be placed in a straight row, build the roof of C the same as that of A.

A roasting pan (or large round mixing bowl) of stainless steel will inexpensively give you a durable bar-type sink for section B. Choose a pan with fairly wide rim and place mastic underneath when screwing it down to the countertop. Finish the countertop first with laminated plastic or vinyl linoleum. Only a cold-water faucet is shown. Running a hot-water supply from the house is optional but usually more of a complication than an asset. The high-







necked faucet shown makes the sink handy for watering potted plants.

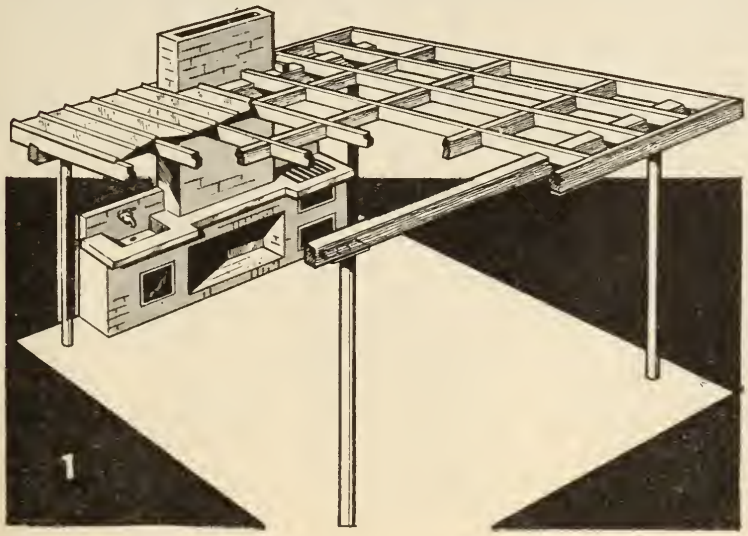
You can tap the cold-water supply from any convenient outdoor faucet, using pipe, plastic pipe or heavy hose, as your individual layout demands. Provide for draining the line in freezing weather. The waste line will also vary individually — from a hose leading to a rock-filled sump to a 1½-in. soil pipe leading to the sewage line. Definitely include the sink trap if connected to the house sewer.

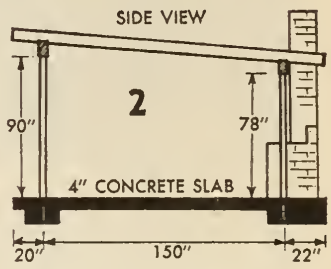
Your electrical wiring also varies. First, check your building code for local requirements. A layout similar to the one shown in the drawings will give good lighting overall and also outlets at the counter and for the TV and hi-fi. The three bullet lights can be switched separately or be all on one switch. This is a grounded 20-amp. circuit from the house, using No. 12 wire. It can be two wires in conduit or two, plus a grounding wire, in plastic cable, depending on code. Note how wiring to the bullet lights can be hidden in the tapered roof beams. However, when you arrange the living-wall sections, tend to run all wiring from above, the plumbing from underneath.

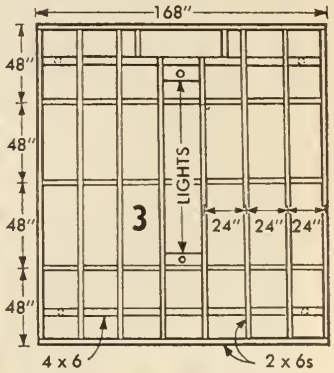
The screened section to extend the living wall out from the house is easily framed of 2x2s as shown in the drawings. Clear or colored flat glass fiber gives it permanent translucent panels. Plastic-coated fly screen gives a budget-wise substitute which will last two to four years. ★ ★ ★

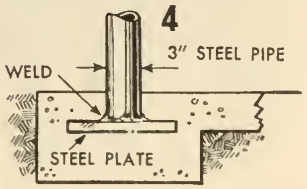
Free-Standing Patio Shelter

WITH THIS easy-to-build roof covering your patio, the caprices of summer weather need not be reckoned with to make a barbecue or lawn party a success. The roof may be added to an existing patio, or a combination patio-shelter-barbecue fireplace can be built as in Fig. 1. Although complete dimensions for the shelter are given, Figs. 2 and 3, the over-all size can be changed to suit individual needs. Rafters are spaced to take stock widths of aluminum roofing. Four steel posts to which plates have been welded top and bottom, Fig. 4, provide adequate support with minimum obstruction to view.—Hi Sibley, Nuevo, Calif









1. Above, flagstone is close-laid in random pattern on concrete with concrete-mortar joints. Straight edges of stones form border of small decorative pool

PAVING PATTERNS FOR YOUR PATIO

HERE ARE SEVERAL WAYS to pave your patio. And by doing the "spade work" yourself the total cost can be kept to a minimum. For small jobs, like stepping stones or precast squares, the concrete can be mixed in a steel wheelbarrow; for larger areas a wooden platform, Fig. 9, is useful. On extensive construction, a power mixer saves time and a lot of hard work. In the latter case, most homeowners will find it more economical to rent the mixer when needed because the comparatively high initial cost, storage problem and infrequent use would not justify owning it.

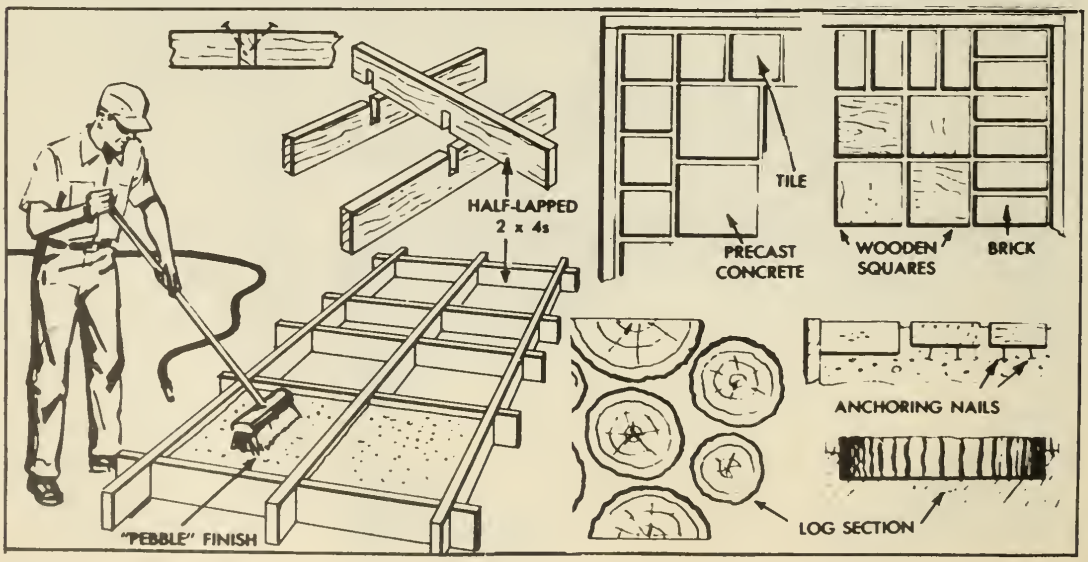
Concrete Paving

A 1:2:3 mixture (cement, 1 part; sand, 2 parts; gravel, 3 parts) is recommended for patio paving. The proportions can be easily and accurately measured in a bottomless box of 1-cu.-ft. capacity, Fig. 9. First, the ground should be prepared. For large concrete slabs, excavate to a depth of 6 in., moisten the soil and tamp it thoroughly. Next, spread 2 in. of sand or cinders at the bottom of the excavation.

When mixing the concrete, place the measuring box on the wooden platform and fill with sand twice. Follow with three measures of gravel and crushed rock not

2. For novel treatment of concrete terrace above, expose gravel aggregate by brushing concrete away from small stones immediately after it has set

3. Below, tile or brick borders add touch of color to patio laid with concrete or wooden squares. Wooden borders for concrete squares are treated 2 x 4s



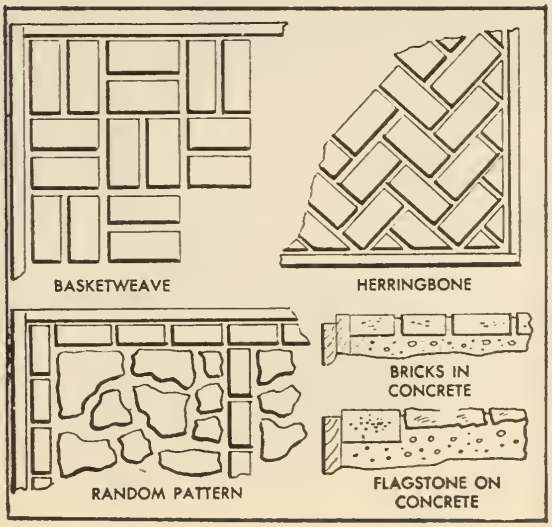
4. Natural flagstone in background is laid on concrete and in foreground directly on soil in informal pattern

larger than walnut size. Mix the mass thoroughly and then add one sack of portland cement. These ingredients should be mixed until a uniform gray color is obtained. Now make a depression in the mound and mix water in it a little at a time, Fig. 12. For dry aggregates (sand and gravel or crushed rock) add 5½ gal. of water, less for moist or wet material. A good mixture should appear plastic, not "runny."

An entire slab of concrete should be poured in one operation and spaded against the sides of the form. Then with a strike board it is leveled even with the top edge of the form which is sloped ¼ in. to the foot to provide the necessary grade for good drainage.

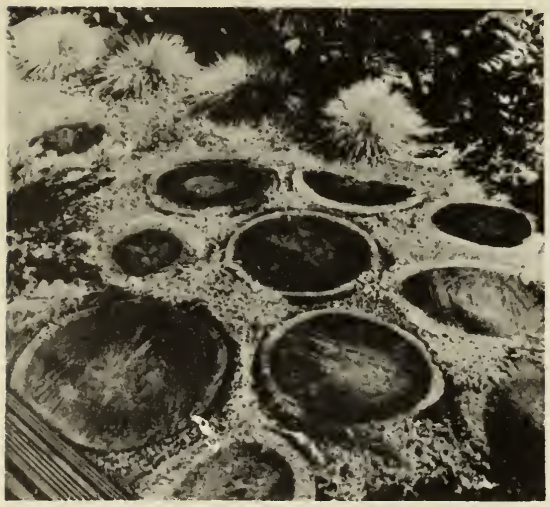
For precast-concrete squares, make a

5. Bricks laid in herringbone pattern are attractive but require cutting at 45-deg. angle at border



6. Formal treatment of patio overlooking valley is this glazed-tile surface laid on concrete slab

7. Above, precast-concrete squares laid on soil, spaced 1½ in. apart with dichondra planted between



8. Redwood-log sections set flush in ground shown above are creosoted on bottom, stained or left natural on top. Use assorted sizes to avoid monotony

form that will produce several sizes and shapes that can be assembled into a random pattern, Fig. 11. The members of the form should be tapered as shown in the end view for easy removal of castings.

Improve Appearance of Concrete

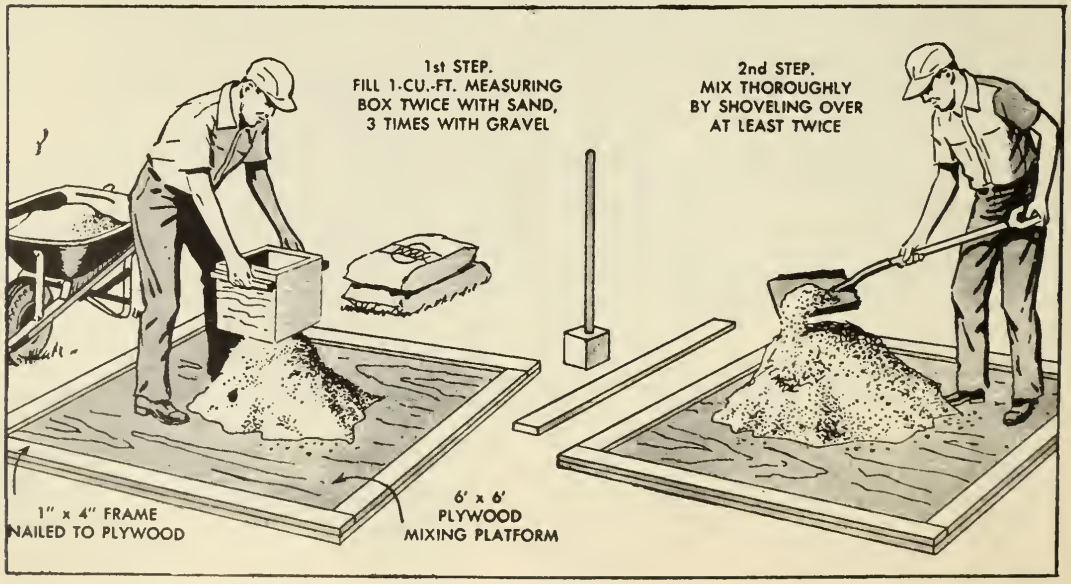
The advantages of paving with concrete are its permanence and low cost. The disadvantages are its harshness of surface, glare and commercial appearance. The latter can be avoided or at least improved upon by staining, adding borders and trim, and modifying the surface.

One way of changing the surface is to expose the aggregate. To do this the mix must be slightly drier than normal. As soon as the cement is poured, level it with a board. Then break the surface by sweeping it with an ordinary push broom to roughen and prevent it from setting, Fig. 3. When the concrete is hard enough to walk on, use a steel brush to expose the larger pebbles. (It will take from 4 to 12 hours to harden sufficiently, depending upon the weather.) During this operation keep water running over the concrete to wash away the loosened particles. When the concrete takes on a "pebbly" finish the job is done.

Concrete exposed to the sun and wind should be kept moist for at least 48 hours after it is laid. Stepping stones cast directly in the ground will not collect water on top when given a slight crown as shown in Fig. 11.

Bricks, laid in basket-weave and nu-

9. Measuring material for small amount of concrete is easy and accurate when 1-cu.-ft. bottomless box shown below is used and mixing done on platform



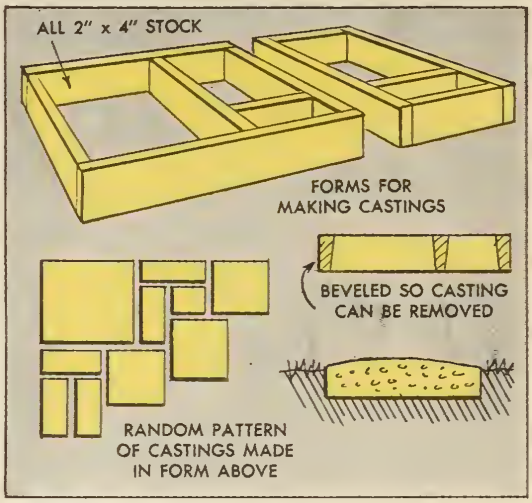
merous other interesting patterns, Figs. 5, 10, 11, are one of the most popular materials used for paving patios. Bricks may be laid on tamped soil, cinders or on concrete with or without cemented joints. On soil, the bricks can be laid close together, or spaced ½ in. apart if you wish grass to grow between them. The herringbone pattern is interesting but requires cutting the border bricks at 45-deg. angles as shown in Fig. 5.

Miscellaneous Patio Surfaces

When available, 3-in.-thick sections cut from redwood logs make a unique arrangement of stepping blocks, Figs. 3 and 8. These should be creosoted on the bottom, and in a damp climate laid on sand. A novel arrangement is to lay wooden squares between brick borders, using protruding nailheads on the underside to anchor the blocks in the concrete, Fig. 3. The monotony of large areas of flagstone can be broken by adding borders or partitions of rectangular stone or brick.

For an unusual effect, pave your patio with concrete blocks set on edge on a concrete slab and with 3-in. asphalt borders around sections containing 24 or more blocks each. After the blocks are laid, fill the border spaces with 2½ in. of crushed rock. Then fill the remaining space flush with cold-mix asphalt. Do not sprinkle cement powder on the asphalt since the black is needed for contrast with the gray blocks. ★ ★ ★

10. Above, brick laid in basket-weave pattern without use of mortar makes interesting walk around patio



11. Forms used for making concrete castings are beveled as shown at right for easy removal of castings

12. Below, mix cement evenly with sand and gravel, then with water until mass is plastic but not "runny"

Outdoor Lighting

Outdoor lighting may be accomplished with as great or as little an outlay of time and money as desired. A wide variety of electrical fixtures and lamps is available, to permit enjoyment—right at home—of sports, games, barbecues, or complete, relaxing rest. Or, extra hours may be added to days for work and odd jobs in the cool of the evening, accompanied by new beauty for the garden, lawn and surroundings.

The architectural design of a house and the layout of the grounds dictate the types of lighting units needed. The types available make the possibilities almost endless. It is not necessary to be an expert to transform home grounds into a new place of hospitality and comfort as property value is increased.

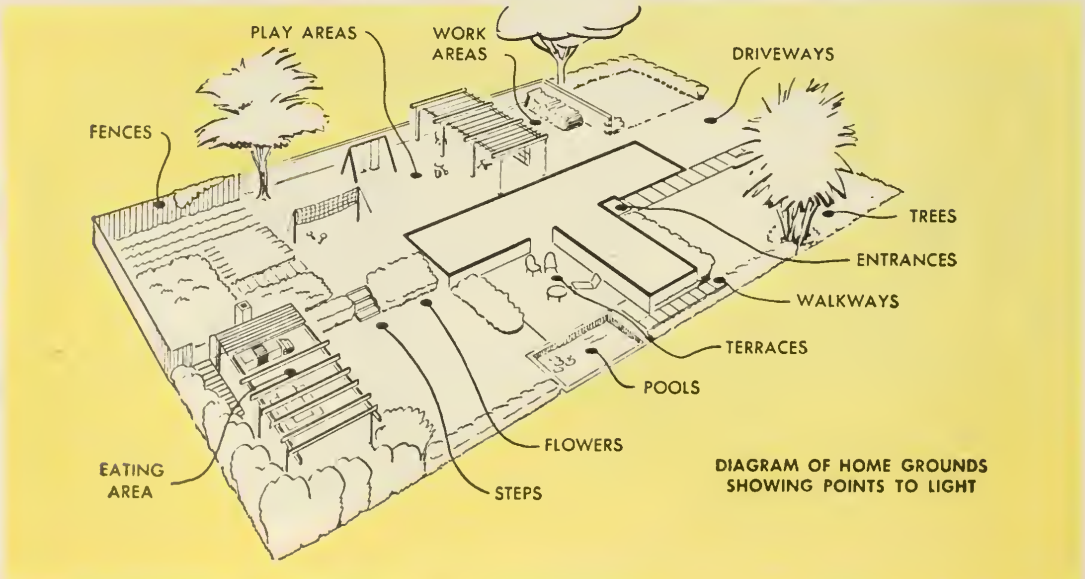
Make a sketch of the grounds to be illuminated. Show the locations of all points—outdoor grill, serving and dining areas, pools, patio, terrace, working spots, attractive garden areas, recreation courts. Sketch permanent outlets on a map, indicating that these areas are to have flood and spot lights. Sketch extension outlets to serve mowers, craft tools, etc. These outlets may also serve outdoor Christmas displays.

Unless there is an experienced engineer to set up the lighting system, it is best to use portable lines first until it is known exactly, by experiment, the kind of installation which will best serve each need. Not all insulated lines are suitable for outdoor use; select only equipment known to be weatherproof and intended for outdoor use.

Planning

Start lighting plans with entrances and walks, selecting types of fixtures which will insure even light distribution and provide clear sight along walks and over steps. A variety of exterior fixtures are available which are adapted to post, wall, or ceiling mounting in styles to go well with any type house. The object should

Mapping the home grounds will aid you in planning outdoor lighting.



Courtesy of Westinghouse

Portable garden lights can be used to illuminate flower beds.

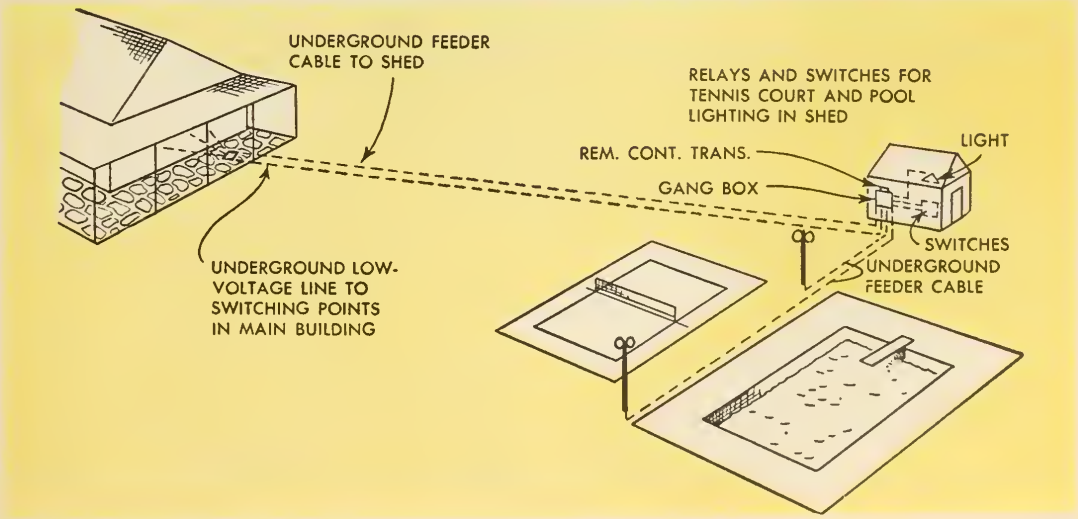
be to secure directional control of the light toward what is to be seen—steps, walks or faces of callers at the doorway. Use etched diffusing glass to reduce bulb brightness and to eliminate glare. Bulb wattage will vary with fixture size and the shielding glass, if any. Usually 40 to 60 watts is right for bracket lamps, 60 to 75 watts for post and lanterns, 75 to 120 watts for surface or flush-mounted fixtures.

General Electric and Westinghouse engineers have perfected a wide variety of equipment adapted to outdoor service to meet every imaginable need. In many parts of the land there are smaller companies specializing in equipment especially adapted to outdoor use.

Choosing Equipment

The choice of lighting units should depend on facility of installation, appropriate design for the purpose, personal taste, and circuit capacity. All units should have finishes which withstand sun, rain, and wind. Aluminum, brass, copper and stainless-steel materials are best for outdoor service.

Lights for outdoor recreation areas may be controlled from shed or house



Courtesy of Kim Lighting Co.

This terrace lamp will light an area 60 feet in diameter.

Lamp size and style are governed either by the equipment or the application. It is necessary to go first by trial, since wattage may need to be adjusted for each specific purpose to get the best results.

There are a few basic rules to follow in order to obtain maximum benefits from a lighting installation at minimum cost:

1. Use a level of illumination adequate for each specific job. In a garden or recreational area, much light will be required to give adequate visual detail, while in larger areas where people rest or where trees and shrubs are displayed, less light is needed.

2. Choose floodlight locations for balanced, uniform illumination. Where beams must be projected at an angle, floodlights should be located so that two or more cover the same area. The more floodlights concentrated in one area, the greater will be the overlap of light beams; shadows will be lessened and greater uniformity will result. Avoid wide variations in the amount of light falling on any area.

3. Select the beam spread and lamp size that give the most satisfactory coverage with the smallest number of floodlights. Use the wide-angle floodlight beams and high-wattage lamps for greater efficiency.

4. Never aim floodlights toward normal lines of vision. Glare interferes with visibility; it may be eliminated by the strategic location of floodlights at the highest practical mounting height.

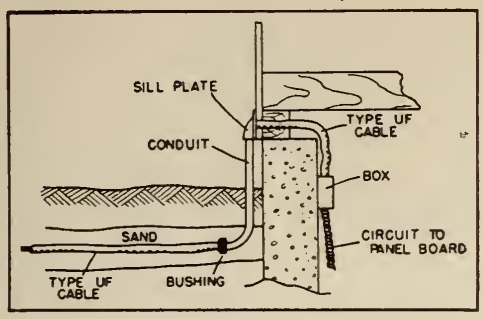
5. Metal poles are best to use for mounting; it is possible to mount and aim the floodlights before each pole is erected. Mountings should permit relamping and maintenance. Hinged poles or pole steps can be used.

6. Be sure to coordinate socket voltage with lamp voltage ratings. Operating efficiency can be obtained only if this is done. Lamps may be operated at more than their rated voltage, when they are in operation for less than 300 hours a year. A 35% increase in light output may thus be obtained with only a 10% voltage increase.

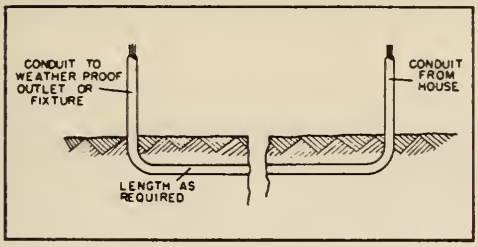
7. Provide adequate wiring. Power losses and low socket voltages result from inadequate wiring. This increases the cost per unit of light output. A 1% drop in voltage results in a 3% loss in light output and a 5% decrease in efficiency.

Wiring to permanent lighting installations should run underground from the point where it emerges from a house to

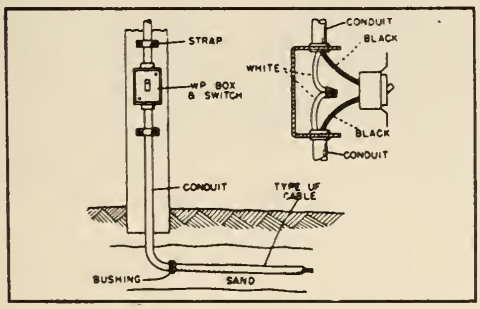
RIGHT: Underground circuit run through masonry wall into basement



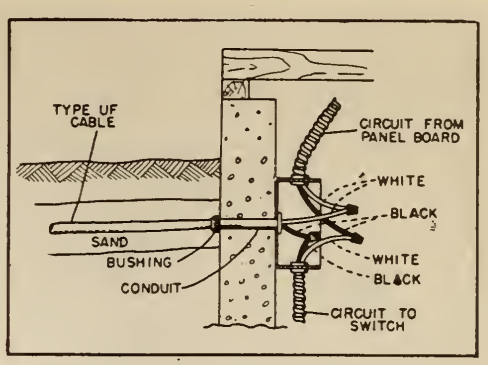
RIGHT: Underground circuit run through panel board and into garage



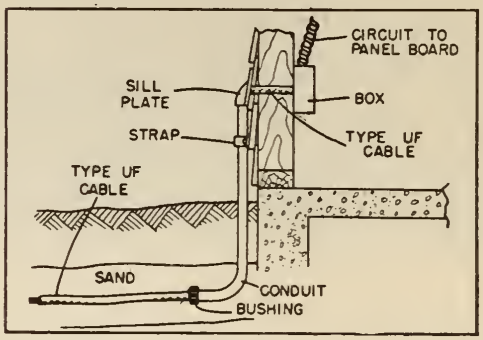
RIGHT: Type UF cable used with conduit for underground circuit



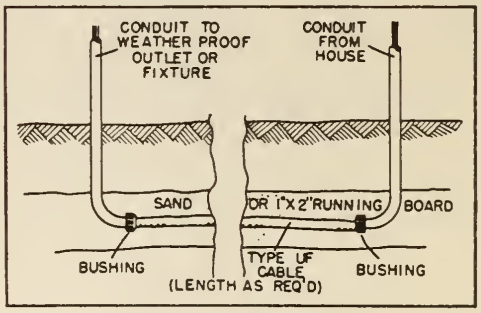
RIGHT: Weatherproof outlet and box, surface-mounted on masonry



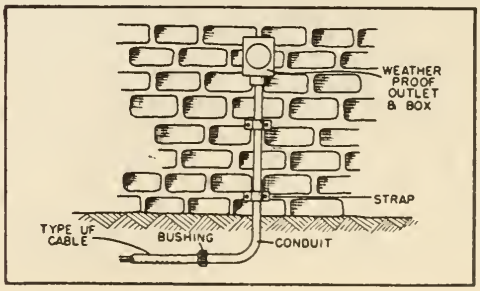
LEFT: Underground circuit run over masonry wall and into basement



LEFT: Rigid conduit used in underground circuit



LEFT: Weatherproof switch for controlling lights in recreation area



Courtesy of Westinghouse

Projector floodlights will provide direct light where needed for outdoor games.

the point where the equipment is to be used. But a combination of overhead and underground wiring is often satisfactory.

Remember that portable equipment—appliances, tools, lighting units—usually must be electrically grounded. The usual method is to connect the exposed non-current-carrying metal parts of the equipment to a grounding conductor which is part of the branch circut. This conductor goes back to the service ground at the service entrance.

Selecting Materials

In selecting circuit materials, the required grounding conductor may be provided by the use of type UF cable which has a grounding conductor in its assembly, by a third wire if overhead lines are used, or by the use of rigid steel conduit as a grounding conductor.

Some outdoor lighting installations do not require grounding, but if any other use of the circuit is to be made, it is best to provide for this in the installation.

Outdoor electric service is supplied by two types of outlets, the permanently installed lighting fixture and the permanently installed weatherproof outlet.

Fixtures, whether post, wall, or ceiling types, should be switch-controlled from a convenient location indoors. In elaborate installations, it may be practical to control some lighting areas — such as play areas — from roofed-over locations other than a house, such as a carport, garage, or breezeway. Use thought in locating switches; one should never be placed away from the house if a trip in the dark is necessary to reach the switch.

Outdoor weatherproof outlets, into which portable fixtures such as those used for garden lighting are plugged, should be switch-controlled; simple plug-ins may be used for barbecues, roasters, radios, etc.

Installing Circuits

A circuit for outdoor use installed in an existing dwelling should be a new circuit originating at the panelboard instead of an extension of an existing circuit. Circuits for outdoor use should be restricted to this single purpose only.

In laying out new outdoor wiring, do

not take for granted the fact that the circuits will be used to provide only lighting. Once circuits are installed and outdoor outlets are made available, appliances and tools may impose a heavy load. No fewer than two 20-amp. circuits should be used. One three-wire 120/240-v. circuit is advantageous in that it may be used for 240-v. appliances or tools.

Most installations will be run either from a basement, where walls are concrete or cement block, or from above ground level, when the panelboard is located in an attached garage or other indoor location at first-floor level of the house.

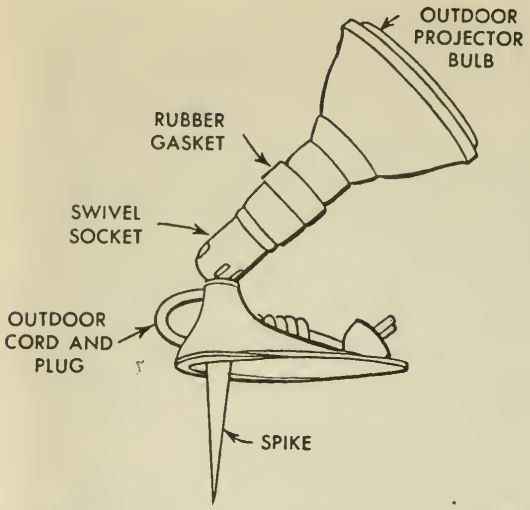
When the panelboard is in the basement, wiring is usually brought outside either through the masonry wall of the basement or through the sill on top of the foundation. If the installation is to be underground, going directly through the basement wall and coming out below ground level is best, as it is least conspicuous. Where shrubbery can hide conduit, it may be easier to come out through the sill. Either way may be used with overhead wiring, since a length of conduit will run up the side of the house. It is well to bring it out at a point where shrubbery partially conceals the installation. In frame houses, circuits for overhead wiring may be fished up through the walls to a point at the desired elevation.

If the panel is in a garage, or a house without a basement, the circuit may be run through the wall of the building at the most convenient point, making it as unobtrusive as possible.

Underground Circuits

Underground circuits offer several advantages. They are not subject to damage from storms or exposed to mechanical damage; they are invisible and do not mar the appearance of grounds and gardens. The most economical installation for feeders and branch circuits is type UF (underground feeder) cable, which is

Outdoor lighting may be used to emphasize scenic points of the garden, such as a pool.
Courtesy of Westinghouse



A 150-watt outdoor projector-type bulb can be used in this "stick-in-the-ground" fixture.

adapted to burial in the ground without extra protection. This is laid in a trench deep enough to prevent possible damage from normal spading. The bottom of the trench should be free from stones. Lay the cable on a layer of sand or sifted dirt. When a cable enters a building or leaves the ground, slack should be provided in the form of an "S" curve, to permit expansion with changes of temperature. Fill openings through foundations with sealing compound so moisture cannot follow a cable into a building.

Underground cable should be installed in continuous lengths from outlet to outlet and from fitting to fitting; splices may be made only within the proper enclosures. If work or travel is to occur on an area where underground cable is laid, protect the cable with a 2 x 4-in. board, placed over it before the trench is filled.

In termite-infested sections, or where lines may be attacked by rodents, extra protection may be secured by the use of galvanized, rigid steel conduit or lead-sheathed armor cable. When rigid conduit is used for the complete circuit run, feeders and branch circuits may be of any approved type of moisture-resistant wire, such as Types TW, RW, RHW, etc.

Overhead Wiring

If the ground is rocky, it is more economical to run outdoor lines overhead. This is also more effective for floodlighting recreation courts and ornamental post lighting if lines can be run high enough to provide proper clearance. Service drop, service entrance or weatherproof wire may be used. Rigid steel conduit EMT, or the equivalent, should be used for mechanical protection wherever wire enters or leaves the ground. Drip loops at the point where the wire leaves the building and where it is attached to the pole are also needed.

The height by which overhead wiring should clear the ground is important for safety. Points to watch are driveways, walkways, places where the possibility of damage caused by falling branches exists, window locations (prevent the conductors from being touched by persons at windows), locations such as flagpoles, TV masts, weathervanes, etc., where lines might foul in wind storms or under ice loading.

As a general safe rule for electric wiring, the following clearances are to be recommended: 8 ft. over flat roofs; 3 ft. over roofs too steep to walk on; 10 ft. above any platform or projection from which the wire might be reached; 10 ft. at the point of attachment to a building; 3 ft. above window opening, porches, patios, or fire escapes; 18 ft. above drives; 10 ft. above walks.

Weatherproof outlets should be installed in the proper locations to allow plugging in small garden lights, power equipment, appliances, underwater pool-lighting units, and the several other units used to enhance grounds and provide more convenient outdoor living. With outlets located where needed, the nuisance of dragging extension lines from the house and the hazard of tripping over cords are eliminated.

Weatherproof Outlets

Weatherproof outlets are best for patios, breezeways, porches and terraces, even when roofed over. Place them in such exposed areas as the side of the garage or house, or on posts or masonry in the yard. Surface-mounted outlets on

The beauty of this night-lighted garden is not lost with the setting of the sun.

posts or masonry should be enclosed in approved weatherproof outlet boxes. Flush-mounted outlets on porches or other roofed-over locations are best standard outlet boxes. All outlets, other than those intended solely for portable lighting equipment, should be of the approved grounding type.

Permanently installed lighting fixtures (not those plugged in to outlets) should be used wherever practicable. Porch lights, wall lights at sides of entrances, floodlights under eaves, post lights for drives and walks, and fixtures for certain sections of the garden should be permanent.

How to Pipe Your Patio With Sound

By James Joseph

MUSIC CAN ADD RELISH to the family barbecue . . . sportscasts can take the drudgery out of gardening . . . the latest news can spark outdoor-party conversation. And they will—if you pipe your patio with sound.

The "piping," moreover, is easy and can be quite inexpensive. All you need is a speaker, some outdoor hookup cable and a weatherproof receptacle. These—plus a little ingenuity—will literally transport your radio or hi-fi system out-of-doors, to any desired spot in your garden or patio.

Your choice of speakers for the great outdoors runs the gamut of the dealer's catalogue. You can use a hi-fi speaker or a less-expensive conventional one. Weatherproofed units, their "innards" protected by a metal or plastic horn, are ideal for permanent outdoor installations. The new "weatherized" units with their impregnated cones and weatherproof enclosures are just as good. Even a regular indoor speaker in some sort of portable enclosure

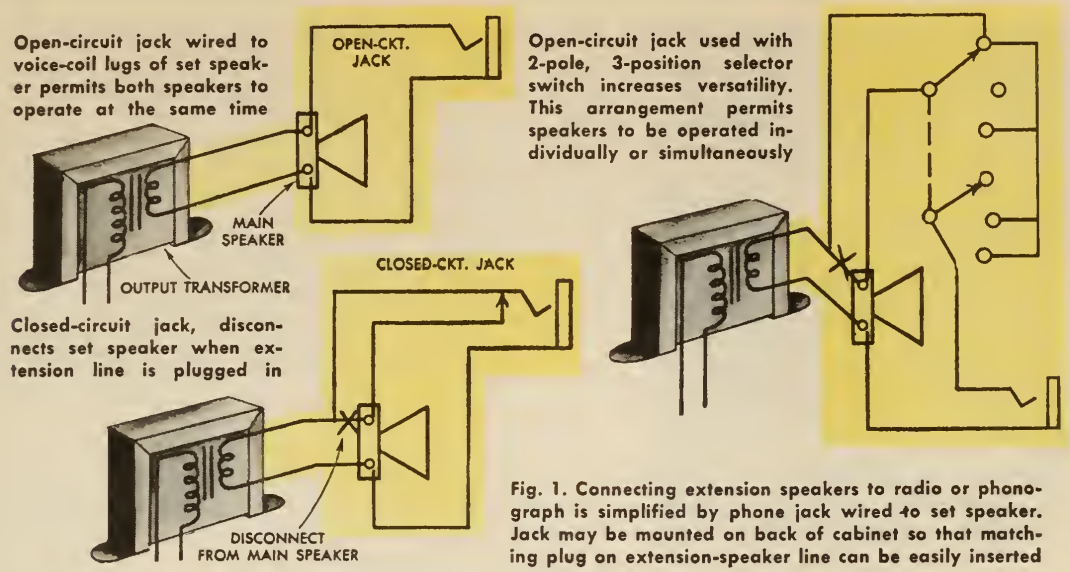


Fig. 1. Connecting extension speakers to radio or phonograph is simplified by phone jack wired to set speaker. Jack may be mounted on back of cabinet so that matching plug on extension-speaker line can be easily inserted

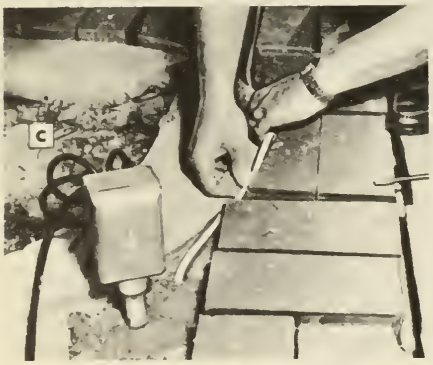
will do very nicely if you take care to protect it from the elements. It all depends on the sound quality you want and, of course, your pocketbook.

You can install one extension speaker or a half dozen, depending on the power which the amplifier of your music system can deliver and the coverage you need. Most radios, even the small table-model variety, can drive one extra speaker without excessive strain. Hi-fi systems with powerful amplifiers can drive more. But outdoors—as indoors—the speakers' total impedance must match the output impedance of the amplifier if best sound quality and maximum volume are to be obtained. The matching isn't difficult but the installation does demand some careful planning for optimum versatility.

Whether you plan to use a number of permanently installed outdoor speakers or a single portable one, you'll find it convenient to install a weatherproofed, plug-in receptacle at every desired speaker location. All receptacles can be wired in parallel with the one closest to the house while a two-wire cable from the latter can be connected to the music system inside through a window or wall opening. This arrangement permits you to change the location of the outdoor speakers to give you just the coverage you need, without resorting to a long and cumbersome cable between the speaker and a single receptacle.

The problem of how to connect the extension-speaker line to the music system deserves some consideration. If you plan to use an ordinary radio or phonograph, it is a relatively simple matter to provide an output jack so that the extension-speaker cable can be plugged in. Several methods for wiring the jack into the circuit are shown in Fig. 1. With this setup the mismatch resulting from the use of a single extension speaker would not seriously affect the performance.

Fig. 2. Typical examples of speakers engineered for the outdoors illustrate styles to fit into any surroundings
A. Lowell's Hifilite; B. Electro-Voice's Musicaster; C. Jensen's Model HF-100; D. Shalda's prong-based Audiolier



For more elaborate installations, where several outdoor speakers are to be permanently connected to a hi-fi system, for example, matching does become a problem. Fortunately, most high-fidelity amplifiers have a number of output-impedance taps (usually 4, 8 and 16 ohms) which can be used for matching purposes. Speaker impedances, too, are standardized. Commonly, the smaller speakers have 4-ohm voice coils while those of hi-fi speakers are usually 8 or 16 ohms. Proper choice of speakers permits virtually any number of them to be connected in various ways (series, parallel or series-parallel) to provide the correct total impedance needed for matching one of the amplifier taps.

Mounting Outdoor Speakers

The large variety of outdoor speakers permits the selection of units for almost any type of installation. Some typical ones are shown in the photographs on page 1488. Illustrated are Jensen's HF-100 mounted on an adjustable patio stand, the tree-trunk mounted University MLC and two versions of Shalda's versatile Audiolier. The basic idea is to mount the speaker near a previously installed receptacle so that only a short length of cable is needed to interconnect the two.

Right here let's differentiate between *weather-proofed* and *weatherized* speakers. The former, like the aforementioned Jensen and University models, and Electro-Voice's spanking-new Musicaster (Fig. 2B), require no protective enclosure. The latter, though resistant to the elements, are mounted in weathertight fixtures, which are often unique and decorative. Typical of these is Lowell's patio lamp—the Hifilite—which mounts a weatherized speaker in a dome-shaped baffle above a light bulb, Fig. 2A. You get all-around sound—and light—from a single fixture. Another version of the Audiolier, Fig. 2D, conceals a 6-in. weatherized speaker in a mushroom-shaped fiberglass housing—ready for "planting" anywhere in your yard or garden.

Cable Considerations

Having decided on the number and type of speakers you need, you'll have to give some thought to the cable which interconnects the various receptacles. First of all, the receptacles themselves must be weatherproof and should be equipped with a two-prong socket which differs somewhat from that of a standard a.c. receptacle. Otherwise it would be too easy to inadvertently insert the matching speaker plug into the a.c. outlet, causing immediate and expensive damage.

The photos in Fig. 3 illustrate the installation of a single receptacle during construction of a brick patio. Here, photo A, a prong-based Audiolier, guyed for extra rigidity, is about to be planted

Fig. 3. Typical outdoor speaker installation shows Shalda's prong-based Audiolier being "planted" during the construction of a brick patio. Direct-burial cable from weatherproof, plug-in receptacle runs toward the house between courses of bricks

beside the receptacle. Wiring of the receptacle is shown in photo B. The two-wire cable enters the receptacle through a hollow-tube base and is connected to the socket. Photos C and D show the cable being routed to the house between courses of brick. Later, when dry cement is tamped between the rows and wetted, the cable is permanently sealed between the bricks.

Additional cable can be run from this receptacle to others located in strategic points throughout the yard.

Indoors, speakers can be wired with common lamp cord, but out-of-doors you need something better. Ideal is the flat lead-in used for TV. Even longer-lasting is direct-burial two-wire cable coated with neoprene which, though constantly exposed to ground moisture, will outlast the best of speakers.

Wire Size (B&S)	Load Impedance		
	4 ohms	8 ohms	16 ohms
14	125′	250′	450′
16	75′	150′	300′
18	50′	100′	200′
20	25′	50′	100′

Table1. Maximum length of cable for 15% power loss

In burying the cable, dig your trench at least 6 inches deep. Once the cable is laid, protect it with strips of wood before filling in the trench and replanting. Though this method of protection isn't foolproof, it'll thwart most shovels and other garden tools —but not gophers.

Actually, the cable needn't be buried. It can be run along fence railings, or tacked under the eaves if this is more convenient. But, no matter what method you use, there's a practical limit to how far you can run your outdoor-speaker leads.

The limiting factor is line loss, which depends primarily on wire size and the voice-coil impedance of the extension speaker. For short cable runs the loss is negligible, but as the length increases an appreciable portion of the amplifier power is sometimes wasted in the cable. A 4-ohm speaker at the end of 18 ft. of No. 22 cable, for example, receives only about 85 percent of the radio's output power.

To reduce line losses, a cable with heavier wire can be employed. Table 1 gives the maximum recommended cable lengths for practical wire sizes and typical speaker impedances. The table is calculated for an arbitrary power loss of about 15 percent. With sufficient amplifier power, greater line losses can often be tolerated, but with careful attention to details such as these, your music system moves outside to add a pleasing new dimension to outdoor living.

Warning: The use of outdoor speakers with some a.c.-d.c. type radios or phonographs could present a shock hazard if the line-cord plug of the equipment is incorrectly inserted in the wall outlet. To eliminate any possible danger, the equipment should be checked with an inexpensive and easy-to-use neon tester immediately after being plugged in.

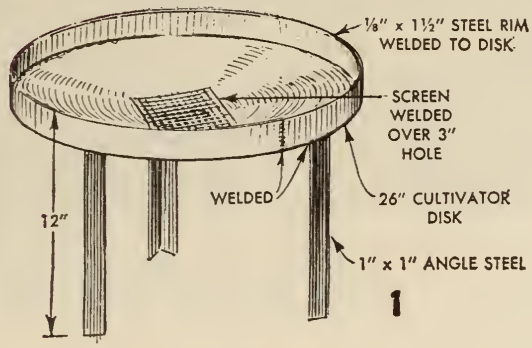
Alternatively, the receiver or phonograph can be equipped with a polarized plug to fit into a correspondingly polarized wall receptacle. This modification, which should be done by a competent radio technician, would assure permanent safety by preventing the line cord from being incorrectly inserted in the a.c. receptacle. ★ ★ ★

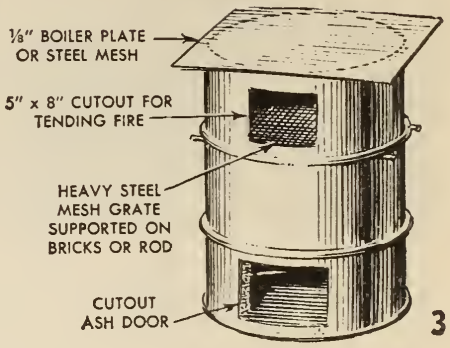
Barbecue "Flame Arrester"

For the most flavorful barbecuing in an outside grill, flames caused by dripping grease should not be allowed to reach and char the meat. A good "flame arrester" can be installed in a grill by placing a piece of metal window screening on the charcoal before the meat is placed over the fire. Hot grease dropping through the screen will flame up, but the flames will stay below the screening rather than flare up over the food being cooked.

DESIGNED FOR your cookout dining pleasure, here is an attractive combination barbecue and outdoor fireplace, a unique table that "serves you," and other furniture pieces and equipment that are inexpensive and easy to make. Construction of each piece is shown in the drawings on the next two pages. The combination fireplace is laid up of bricks on a concrete foundation to the dimensions given in Fig. 7. The grill has no smoke opening into the fireplace flue since most barbecuing is done over charcoal.

An overgrown lazy susan, the table detailed in Fig. 2, is ideal for self-service barbecue dining. The rotating top permits guests to select food from any dish desired without having to file around the table. This arrangement is especially convenient when all guests can be seated within reach of the table. Built of ½-in. exterior plywood, the table has a 48-in.-dia. top that rotates on a 36-in.-dia. sub top mounted on hairpin legs. The rotating feature is provided by a stud that serves as a shaft and four ball-type glides or casters installed as detailed in Fig. 2. The plywood disk that takes the smooth end of the stud (cut from a ½-in. bolt), is glued and screwed to the underside of the table top; the other disk is fastened to the underside of the sub top in the same manner. Both disks are 3 in. in diameter. The threaded end of the stud is turned into an undersize hole drilled through the sub top and disk as shown in the sectional detail. Note that a brass bush-

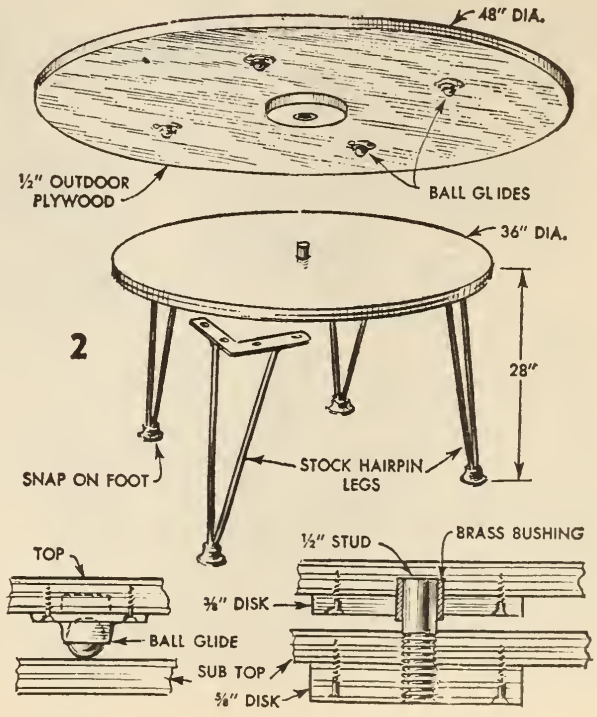


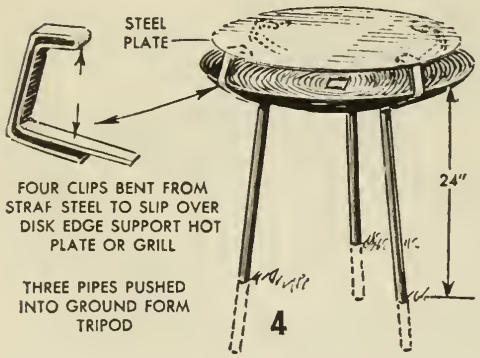


ing in the top takes the end of the stud. The ball glides roll on the sub top when the top is rotated, providing an easy, stable motion, even when the table is heavily loaded.

A companion bench for the table is detailed in Fig. 8. After the leg-and-back support assemblies are welded from ½-in.-steel rod and ⅛ x 1¼-in. flat steel, the seat and back are cut to size from pine or fir lumber and bolted to the supports as shown.

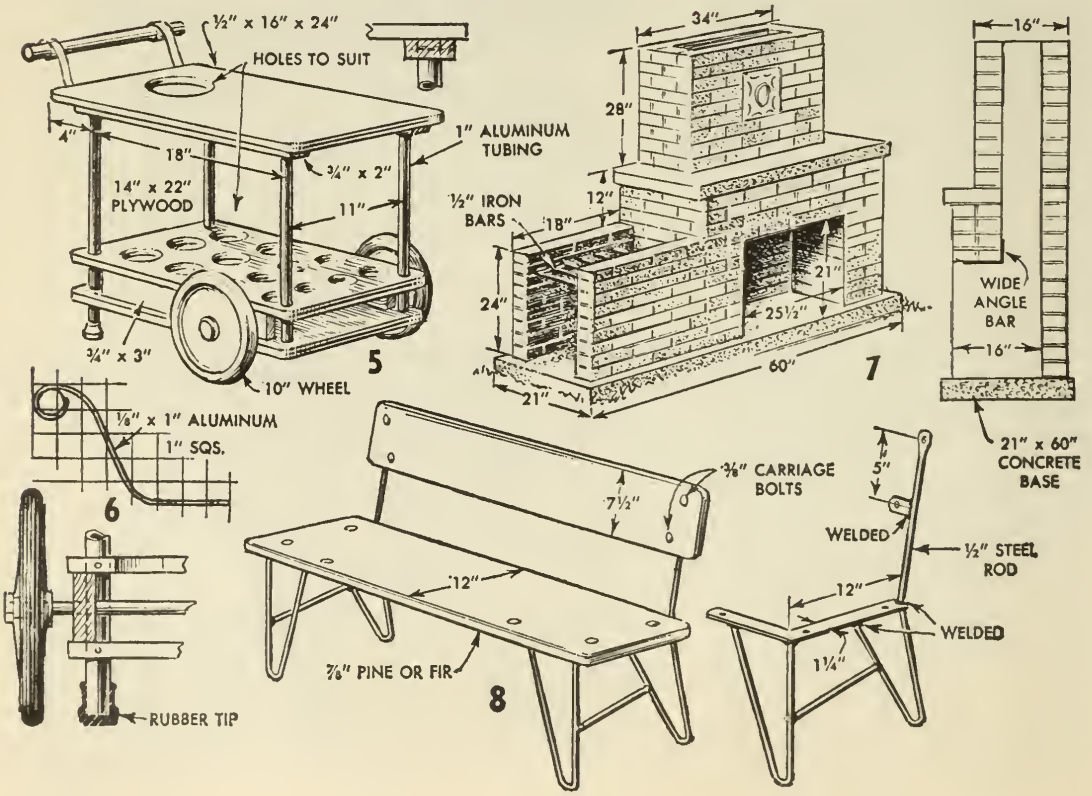
For those whose outdoor living consists of only an occasional cookout, the grill shown in Fig. 1 is about the least expensive you can make to serve the purpose. It consists of a large cultivator disk having a steel rim welded around the edge, and a piece of hardware cloth welded to it over a hole in the center. A portable grill that is somewhat similar and about as inexpensive, is shown in Fig. 4. This one utilizes a large disk but has a steel-plate grill supported above the fire by removable brackets. The legs are not welded to the disk. Instead, they are merely driven into the ground so as to support the disk tripod fashion. This type of assem-





bly permits the entire unit to be dismantled and stored in a small space. Where efficiency and low cost are more important than appearance, it is hard to beat the oil-drum barbecue detailed in Fig. 3.

Highly functional and easy to move about on rough surfaces, the service cart detailed in Fig. 5, will be one of the most popular items of your patio accessories. It can be used as a beverage-and-food dispenser, as well as for carting food and dishes from house to patio and return, saving many steps for host and hostess. The top, bottom and glassware shelf are ½-in. exterior plywood cut 16 x 24 in. for the top and 14 x 22 in. for bottom and shelf. All glassware holes are the same size, except for the row at the back of the shelf, which are cut large enough to take 1-qt. beverage bottles. The hole in the top may be cut to take a plastic ice bucket or a serving dish, as desired. All wooden and metal parts of the furniture and equipment should be given protective coatings of paint or varnish. Liquid preservative should be applied to the wood parts first. ★ ★ ★

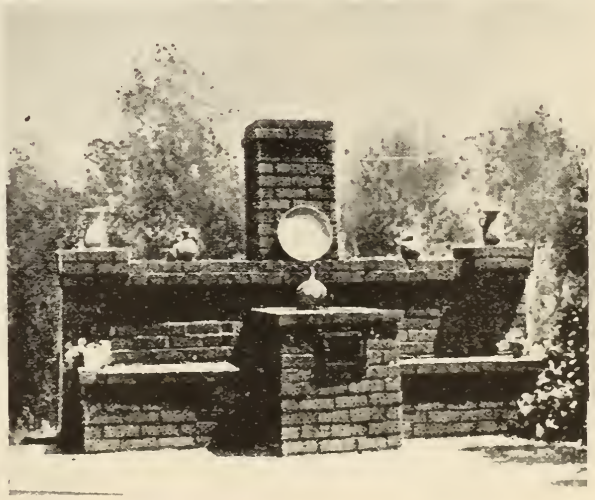


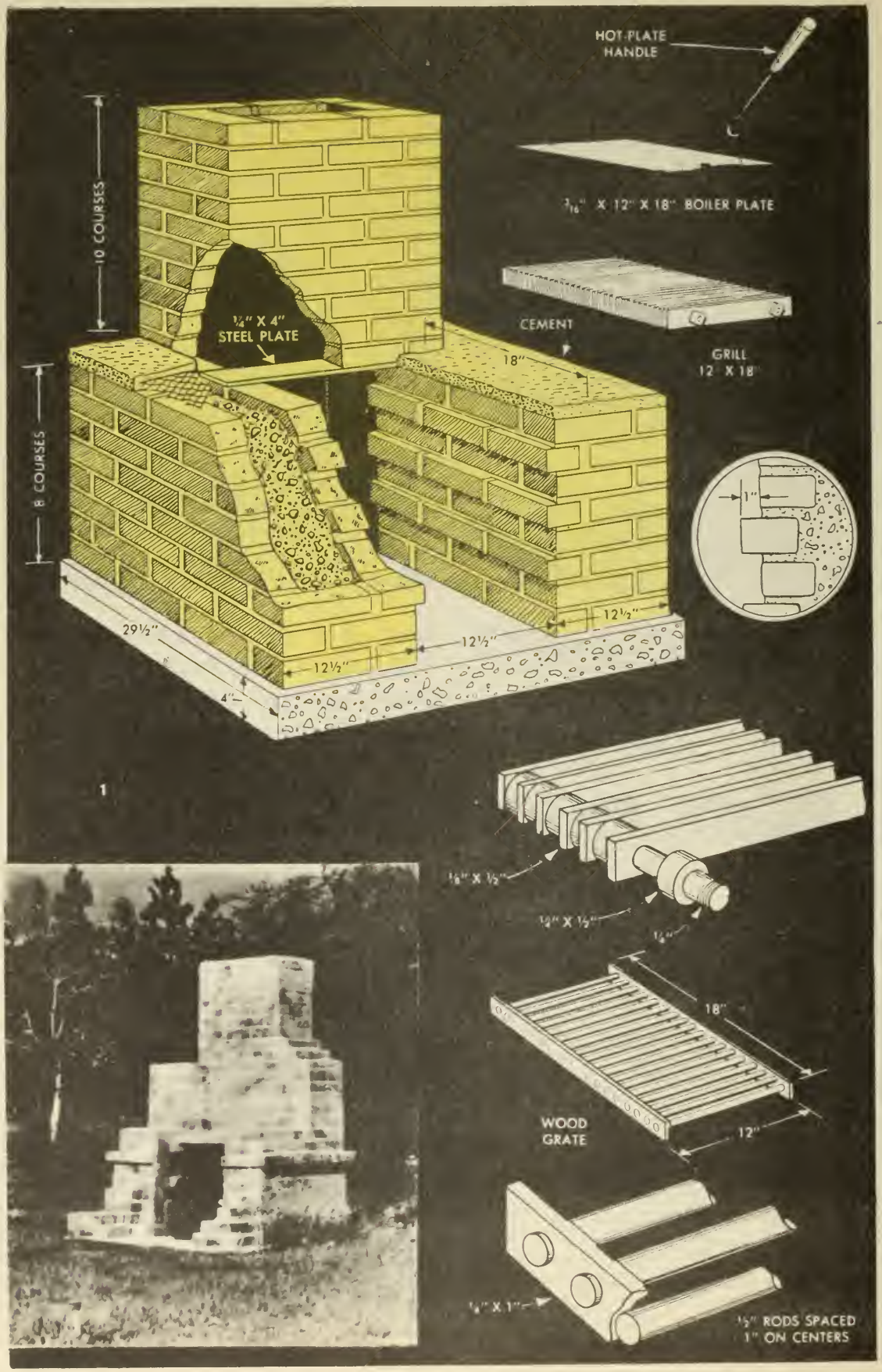
FIREPLACES OF BRICK AND STONE

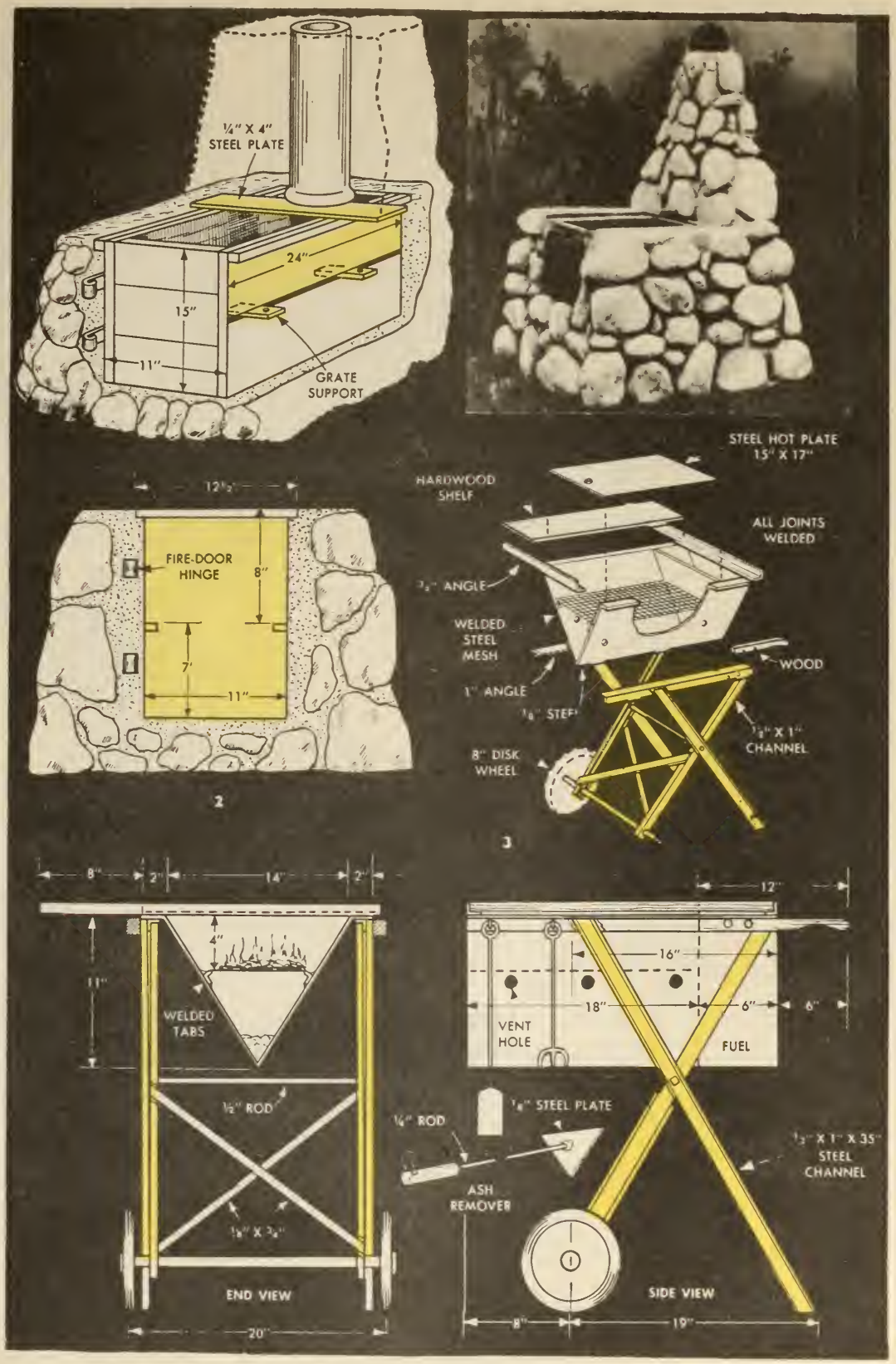
Brick and stone fireplaces built into outdoor living rooms are made both decorative and useful by the addition of simple design details

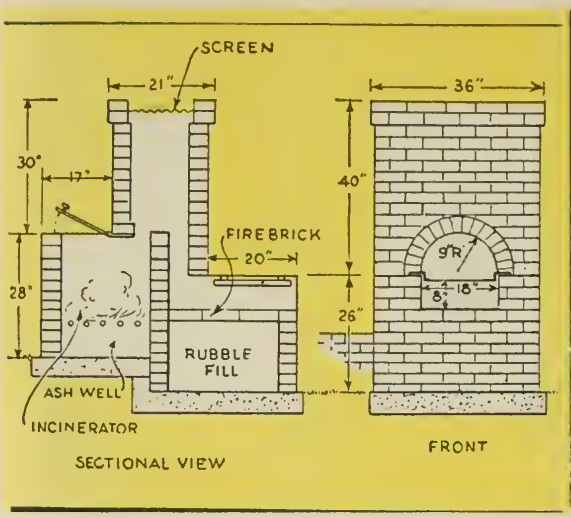
IN THE MODERN trend to outdoor living the simple fireplace has evolved into a complete open-air-kitchen unit fitted with grill, charcoal and wood grates, and work tops especially designed for the convenience of barbecue chefs. When built as a permanent unit of stone or brick, the kitchen also serves as an attractive terminal feature of the garden plan. The types pictured above and at the right are examples of units that fulfill this twofold purpose. Both units have the same basic design features, but it will be noted that the structural details have been worked out to suit individual settings. In both designs the stepped construction provides ample work space and the overhangs introduce horizontal shadow lines that give a feeling of width.

Kitchens pictured above and below are of similar basic design but structural details have been worked out to suit individual settings. Note offsets and overhangs in the walls

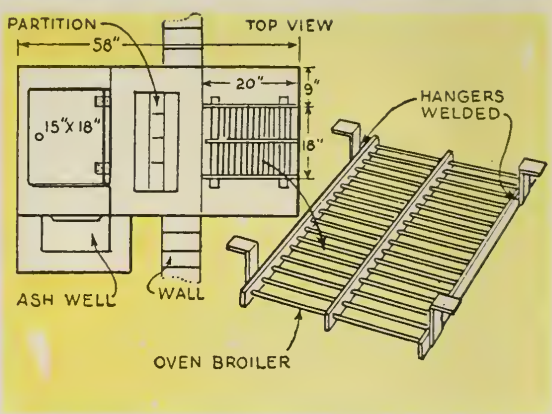



HOT-PLATE HANDLE
3/16" X 12" X 18" BOILER PLATE
10 COURSES
8 COURSES
¼" X 4" STEEL PLATE
CEMENT
18"
GRILL 12" X 18"
1"
29½"
12½"
12½"
12½"
4"
1
⅛" X ½"
¼" X ½"
¼"
18"
12"
WOOD GRATE
¼" X 1"
½" RODS SPACED 1" ON CENTERS


¼" X 4" STEEL PLATE
24"
15"
11"
GRATE SUPPORT
12½"
FIRE-DOOR HINGE
8"
7"
11"
2
STEEL HOT PLATE 15" X 17"
HARDWOOD SHELF
ALL JOINTS WELDED
¾" ANGLE
WELDED STEEL MESH
WOOD
1" ANGLE
⅛" STEEL
⅛" X 1" CHANNEL
8" DISK WHEEL
3
8"
2"
14"
2"
11"
4"
WELDED TABS
½" ROD
⅛" X ¾"
END VIEW
20"
12"
16"
18"
6"
6"
VENT HOLE
FUEL
¼" ROD
⅛" STEEL PLATE
ASH REMOVER
⅛" X 1" X 35" STEEL CHANNEL
SIDE VIEW
8"
19"



THE GRILL FIREPLACE shown above will blend in excellently with a home of traditional design. The usual iron support at the front side of the chimney is replaced here by a masonry arch which does not require skilled masonry work because of its small radius. An incinerator is incorporated in the design, which can be eliminated as in any other barbecue fireplace by moving the rear wall forward to replace the partition. The firebrick floor of the firebox here is best left unmortared, loose on top of the rubble or dirt fill. Thus the firebrick can be replaced, if needed, and will not crack if the fill settles. The grill rests on top of the brick firebox, this also is not mortared in so that it can be removed completely to use the barbecue for a social fire. The fireplace can be built on two levels as shown, or one, and has a high chimney for a good draft with the arched opening. Construction requires about 500 bricks.



A large simple fireplace like the one at the right can be built in any spacious yard of park-like landscaping and can utilize any stone from the property. In this example, no attempt has been made to provide a broiling grill or hot plate. The crossbars of pipe or ½-in. iron rod are simply supports on which the grill or hot plate can be laid. This fireplace will, of course, serve as a spot for a cheerful open fire in the evenings.

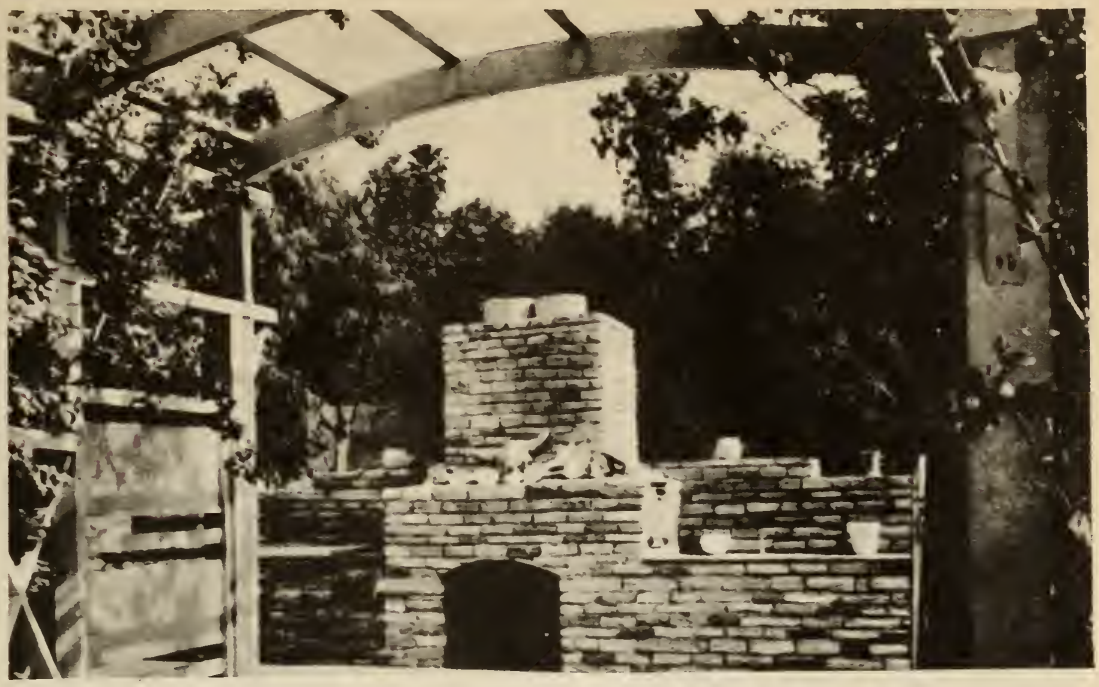
TWO FIREPLACES—

ONE PLAIN,

ONE FANCY—

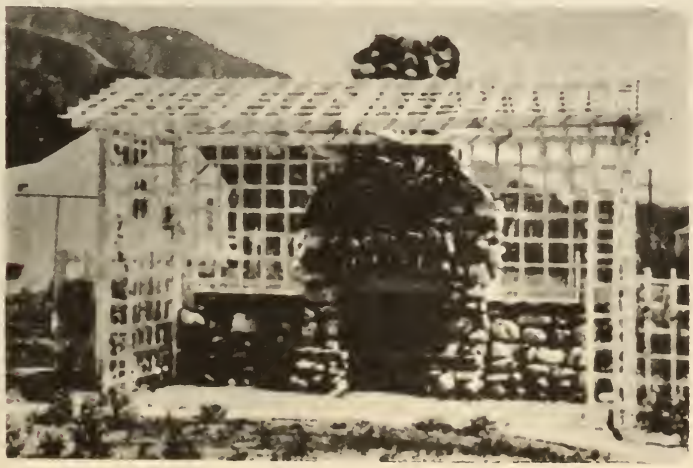
FOR YOUR

GARDEN



Offset walls extending each way from the fireplace opening enclose the outdoor dining room and provide space for utensils or decorative pottery. Constructed of selected flat stone of varying thicknesses

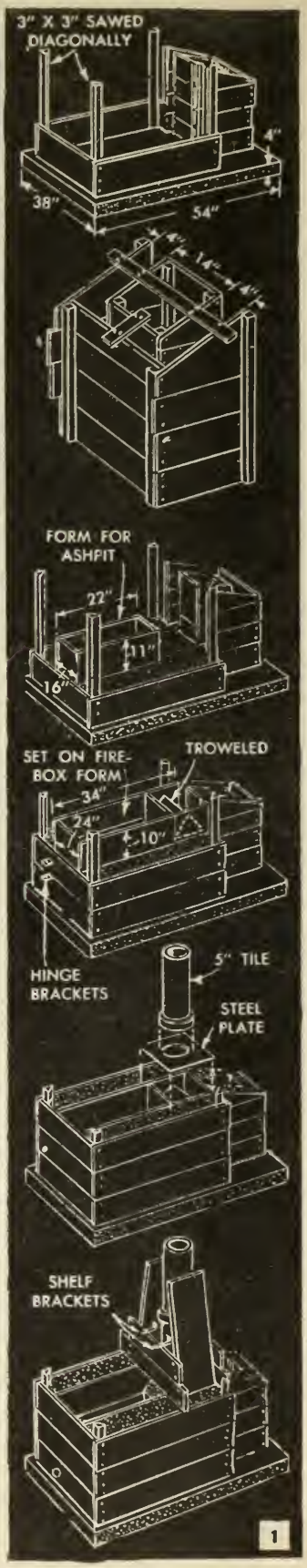
Above, picnic chefs often prefer a simple brazier because of its easy portability and open-fire atmosphere. Below, another true fireplace constructed of field stone. An open-work trellis frames the structure and also provides a slat shade. Note stone arch over fireplace opening



Typical construction of a fireplace with brick and rubble is shown in Fig. 1. Other details show construction of a grill and hot plate. A fairly common method of building a fireplace of natural stone is shown in Fig. 2. In this case, a wooden box serves as the form for the cement and stone work. The box form is built of rough lumber and is later burned out when the concrete has cured.

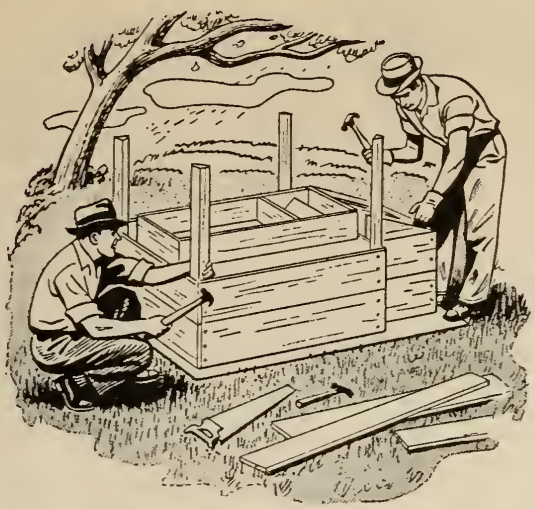
The principal advantages of the barbecue cart, Fig. 3, are portability and the small storage space required when the cart is not in use. As will be seen from the details, the cart is simple in construction and is especially adapted for use as a charcoal grate or grill. The unit is of all-metal construction except the wheels, shelf and handles. A novelty among outdoor kitchens is the simple brazier pictured at the left. The units pictured above and at the left are true fireplaces with an offset forming a mantel. Offset walls extending on both sides enclose the outdoor dining room. If desired, a swinging iron crane can be installed inside the fireplace opening. ★ ★ ★

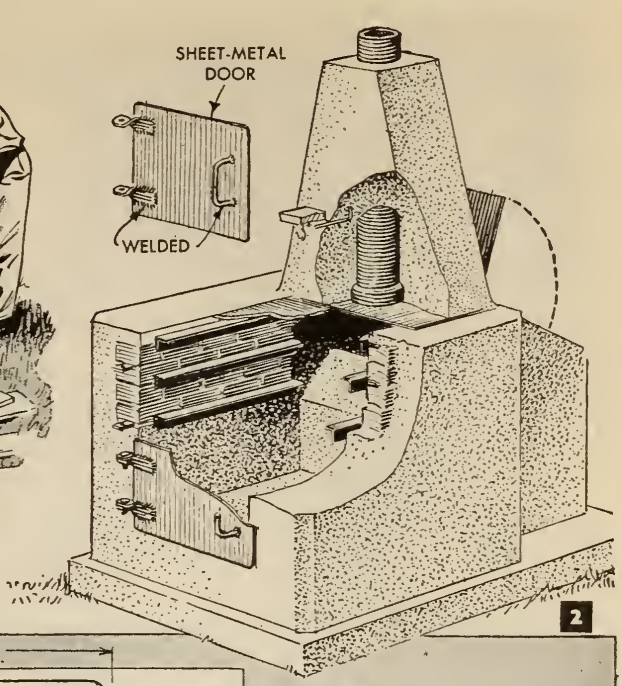
FIREPLACES OF POURED CONCRETE

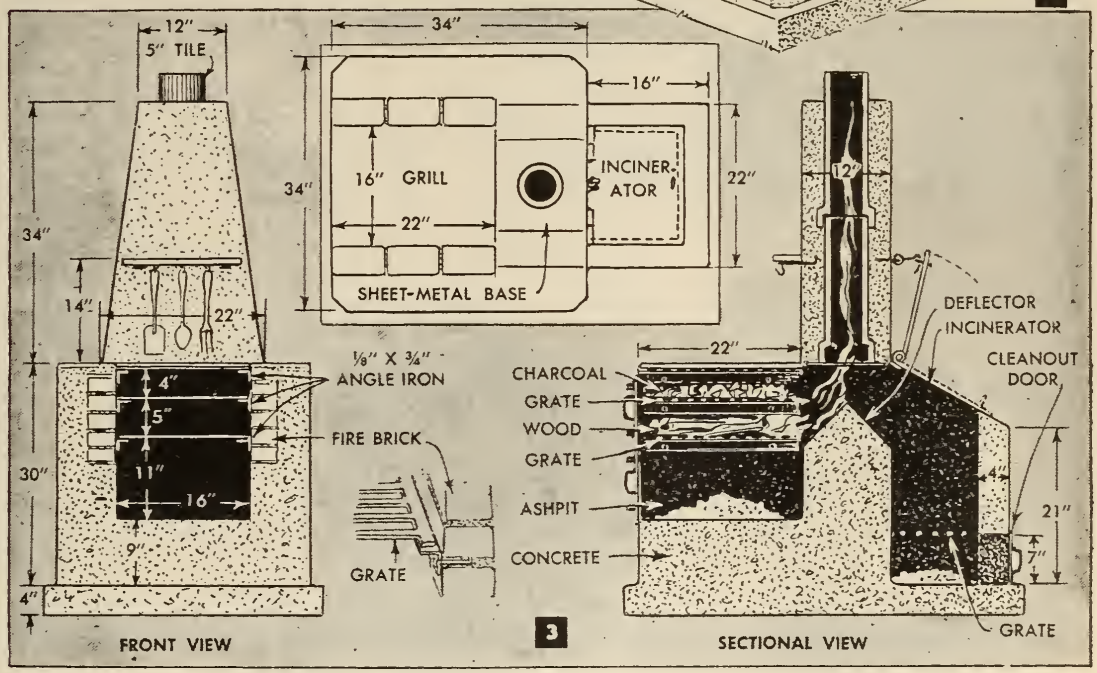


Here is an interesting and durable barbecue fireplace, its poured-concrete construction giving unusual and clean lines that blend in well with many of today's homes. You can alter the shape of the chimney at will—say to a massive modern square to match modern furniture—but do retain its 5-in. inner tile for proper draft. The construction diagrams include an incinerator on the rear side. If no incinerator is desired, you will simply stop the forms at the back of the chimney. This fireplace uses either wood or charcoal. Its grill can be open for broiling or be a solid hot plate.

The forms, of any lumber, should be oiled to prevent their sticking to the concrete. Fig. 1 shows the simple steps of their construction: the needed dimensions are given in Fig. 3. Fig. 2 shows how the grates and chimney should be placed. First, dig the 4-in. deep excavation for the slab foundation. After this slab has been poured and hardened, use 9-in. boards to build up the sides of the main form to the bottom of the ashpit and also assemble the double form for the incinerator, placing iron bars for the incinerator grate in the form. Note that the main-form cleats are triangular and are nailed inside the corners, while those on the incinerator are located on the outside. Fill the main form and incinerator form to the top of the 9-in. boards and allow that concrete to harden. Next, place the ashpit form in position, add boards to the main form until level with the top of the ashpit form, and pour the concrete as before. Allow this portion of the concrete to harden, then erect the firebox form above the ashpit



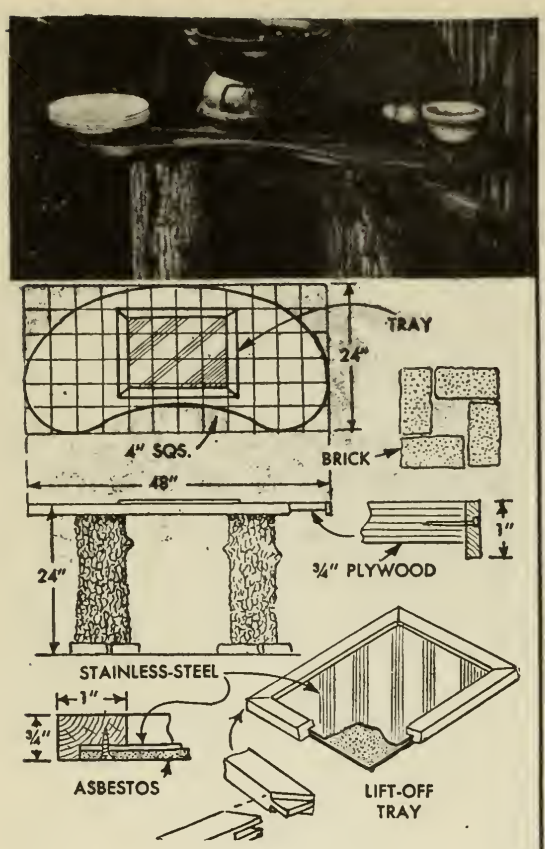




form, adding boards to the main form to bring it level with the top of the firebox form. The firebox form is wider than that for the ashpit to allow for inserting the firebrick later. Pour to the top of the main form and trowel the top of the incinerator to shape. When building up the main form, insert the lower hinge bracket for the ashpit door. The others are set in the firebrick mortar.

After the concrete has set, remove the forms and fashion the deflector with a trowel. The chimney is supported by a rectangular piece of heavy-gauge sheet metal with a hole cut in the center. Set two sections of 5-in. tile over the hole and build up the form as in the lower detail, Fig. 1. Before pouring the concrete, set in the shelf brackets and the eyebolt for the incinerator-door hook.

As the firebrick is laid, studs for the angle-iron supports for the hot plate and grates are embedded in the mortar. The ashpit and firebox doors can be made from sheet metal with handles and hinges welded on, and the incinerator cleanout door may be a piece of sheet metal bent to fit snugly in the rectangular opening.



Outdoor Brazier Table

This kidney-shaped table is designed especially to hold a table-top brazier, so often used when doing back-yard cooking for just a few people. There also is ample space on the table for dishes and utensils used with the brazier. When the cooking equipment is stored away, the table remains as an attractive piece of yard furniture, and can be used for serving cooling drinks and sandwiches. The lift-off tray has a bottom consisting of a sheet of stainless steel over a piece of asbestos to provide a heat shield for the table, and to contain any hot grease spilled from the cooker. When the brazier is removed, the tray can be used for serving beverages and snacks. Two lengths of tree trunk, their ends cut as square and parallel as possible, are the "legs" of the table. Bricks, arranged as shown in the detail, are used to hold the lower ends of the legs in place. For a more permanent installation, the legs can be set in concrete. The plywood top of the table, which is removable for storage during bad weather, is trimmed with a 1-in. strip of wood, plastic or metal. The top should be given several coats of paint, and the tree trunks treated with wood preservative.

CHINESE-OVEN BARBECUE

By Brewster Morgan

(Courtesy of *Arizona Highways* Magazine)

CALLED A CHINESE OVEN, the barrel-shaped barbecue pit illustrated on the facing page cooks foods slowly and smokes them, a process that imparts a flavor duplicated by no other method. An advantage of smoking is that meats, fish and vegetables can be cooked together without interchange of flavors.

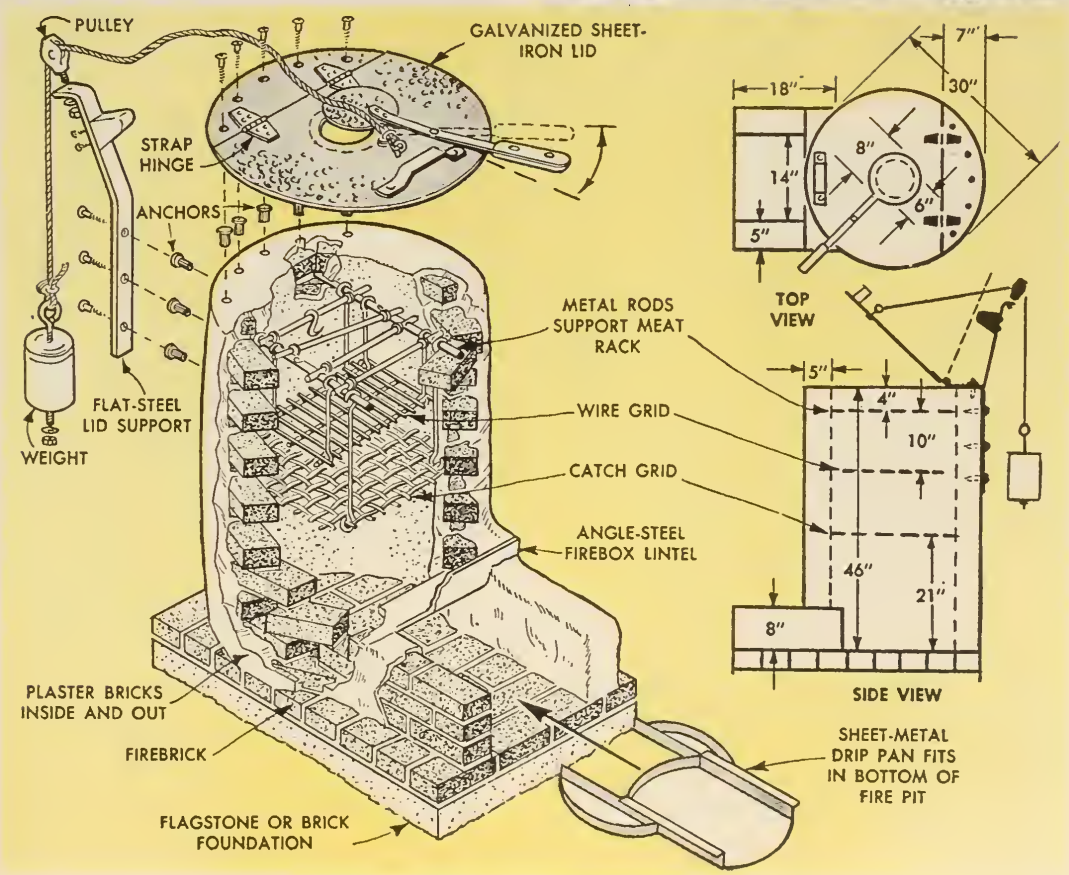
The oven can be built as easily as most barbecue pits, and usually requires less space. Oven dimensions are only suggested, since its size would depend on the amount of food that will be smoked. Flagstone, brick or poured concrete can be used for the foundation. Heat-resistant mortar then is used to set a layer of firebricks on the foundation for the oven floor. About three courses up, the angle-steel lintel is fitted over the firebox opening. Two metal rods, which support the meat racks, are mortared in place about three courses from the oven top. If the oven is not as barrel-shaped as you wish, this can be corrected by doing some "sculpting" with the fire-resistant plaster troweled over the inside and outside of the oven. When applying the plaster, insert screw anchors to provide a means of attaching the lid and its flat-steel support. Trowel the top of the barrel flat as shown in the side view.

The support is a length of flat steel bent at its top end and fitted with a pulley over which is run the cord holding the lid counterbalance. A wooden block on the support acts as a lid stop. Sheet metal is used for the lid which is hinged as indicated. A 6-in. hole in the lid center provides draft, and is covered by an 8-in. disk fitted with a handle that is pivoted to the lid. This is the adjustable damper. The meat rack consists of sharpened hooks bent from heavy wire and slipped over metal rods that lay in notches filed in the support rods. Vegetables, hot dogs and the like are smoked on the wire grid suspended from the support rods on wires. Heavy screen wire is used for the catch grid which is designed to catch any food falling from above. Sheet metal is used to form the three-piece drip pan located in the bottom of the oven.

Firewood should be of a type that makes fragrant smoke, such as hickory. Build the fire in the firebox outside the oven. Allow plenty of cooking time, since smoking takes longer than other methods. ★ ★ ★

Chinese oven, used for centuries by the orientals, cooks foods slowly and imparts a flavor that no other cooking method can produce. Fire does not contact food; only fragrant smoke enters oven

Dimensions of oven as given below can be changed to suit individual requirements. Firebrick and heat-resistant mortar and plaster can be purchased at most building-supply dealers or at larger lumberyards



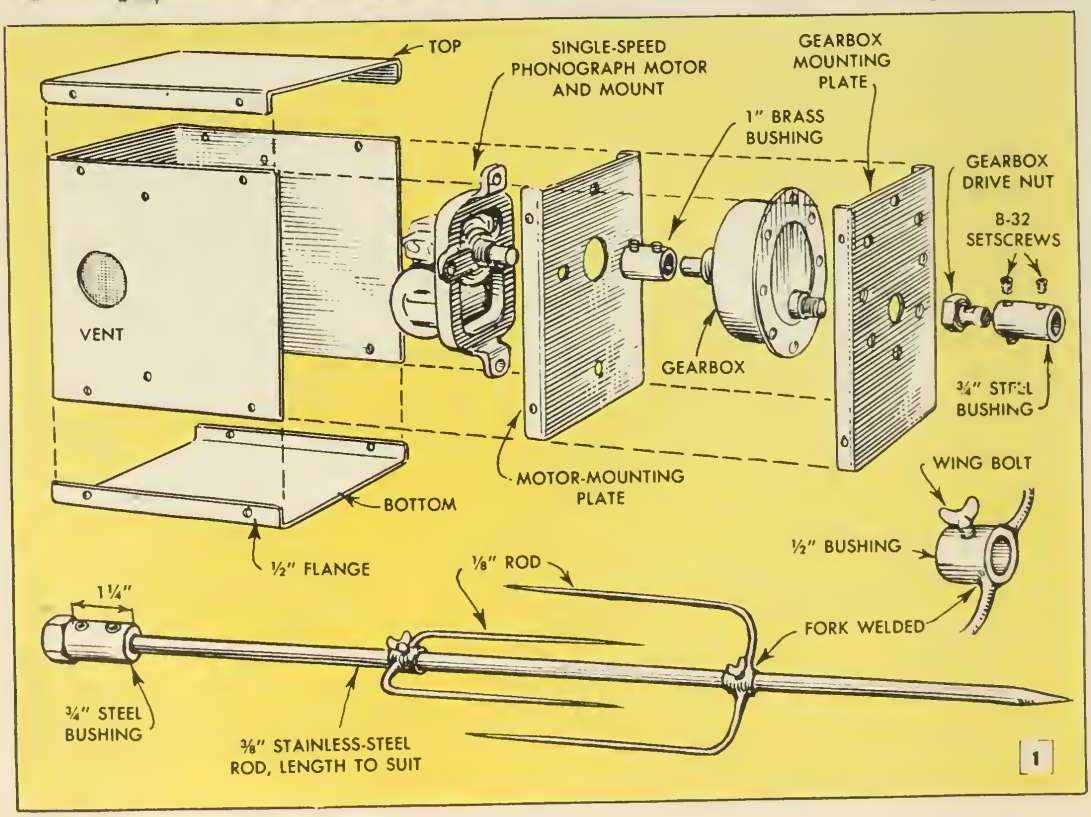
Motor-Driven Barbecue Spit

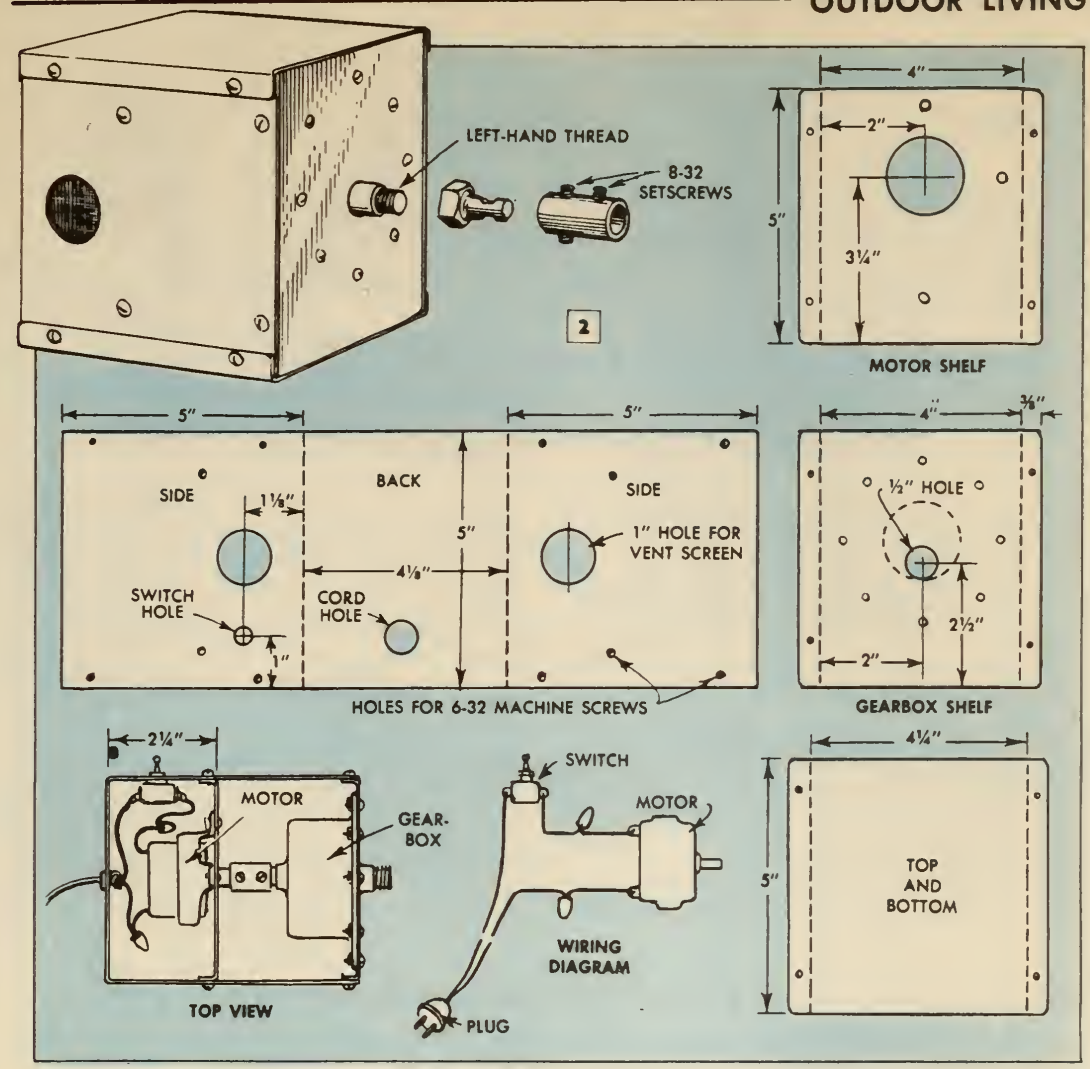
IF YOU ENJOY the delights of food barbecued over an open fire but hesitate at the thought of hand-turning the spit, a motor-driven spit is the answer to your problem.

The spit, detailed in Fig. 1, is powered by a single-speed phonograph motor coupled to a war-surplus gear-reducing unit. The gearbox, in turn, is coupled to the spit rod. Two welded forks slide on the spit and can be locked in any position by means of hand-tightened wing bolts. The spit power assembly is mounted in a sheet-metal box and fitted with a convenient toggle switch.

The sheet-metal box should be made according to the dimensions in Fig. 2. Do not drill holes for mounting the motor until the motor is obtained; different makes of phonograph motors have different sizes and types of mountings. The sheet metal used in making the box does not have to be too heavy, but should be thick enough so the heat of a fire will not cause it to buckle or warp.

The gear-reducing unit for the spit is available at war-surplus stores which handle electronic and radio equipment. The



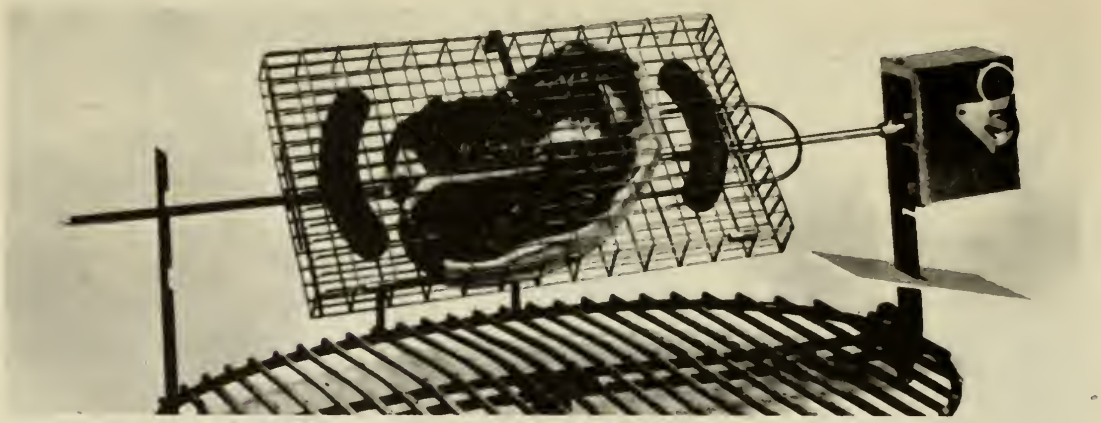


gear reducer is the type used at the rear end of a dynamotor and has the part number PE 1016. The end of the reducer driving shaft has a left-hand thread and is fitted with a specially shaped connecting nut which comes with the gearbox. Two small ears on the driven shaft of the gearbox are cut off to permit fitting a brass bushing which couples the shaft to the phonograph motor. The bushing is a 1-in. length of brass rod, drilled at one end to receive the gearbox driven shaft, and at the other end to receive the phonograph-motor shaft. The bushing is cross-drilled and tapped for 8-32 setscrews.

The electric motor for the spit power unit can be salvaged from any discarded phonograph. If none is available, a new motor can be purchased at most radio-supply houses. To assure accurate alignment between motor and gearbox, the motor is fitted on its plate and the plate is marked and drilled. After the motor is bolted in place, the gearbox is coupled to it. The gearbox plate now is marked and drilled and both plates are bolted to the inside of the sheet-metal box.

The spit is a length of ⅜-in. stainless-steel rod. Its length is determined by the width of the fireplace or barbecue pit over which it is to be used. The sliding forks on the spit are bent from ⅛-in. steel rod and each tine is filed or ground to a smooth point. The forks are welded to bushings which are lengths of ½-in. rod, drilled to slide freely on the spit. The bushings are cross-drilled and tapped to receive wing bolts which hold the forks in the desired position.

The bushing which couples the spit to the gearbox is a 1¼-in. length of ¾-in. steel rod. One end of the bushing is drilled to receive the spit rod. The opposite end is drilled to slip over the connecting nut on the end of the gearbox shaft. The bushing is cross-drilled and tapped to receive 8-32 setscrews. Two setscrews, one on each side of the shaft, seat on the flat surfaces of the



connecting nut. The spit now can be removed or replaced simply by turning the nut on or off the gearbox shaft.

A toggle switch is mounted on the side of the sheet-metal box and is wired to the motor and to a lead-in cord. For convenience, a socket or receptacle may be mounted on the box and a removable extension cord used.

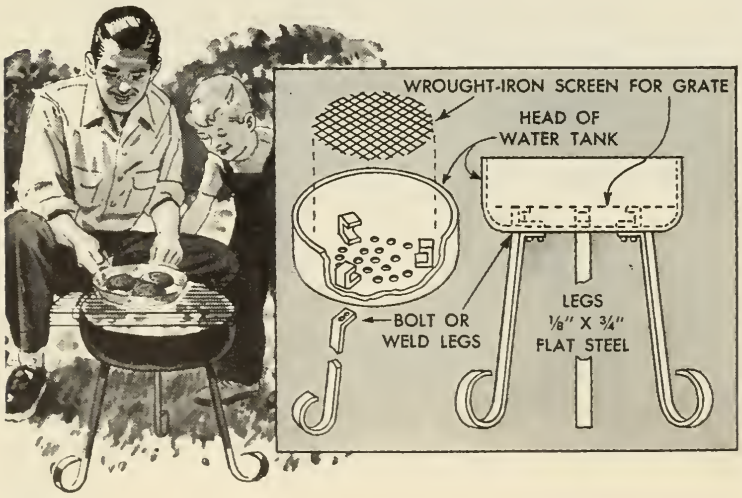
A vent, covered with screen wire, is located on the side of the box to provide ventilation for the motor. It may also be necessary to line the box with some sort of insulation if the power unit is used especially close to the heat of a fire.

If you do not care to make a powered spit, there are several manufactured units available. A spit that is especially ideal is one called "Roto-Wizard," manufactured by U. S. Associates, Inc., of Los Angeles, Calif. It is powered by two D-type flashlight batteries, which will run the spit for about 10 hours of continuous operation, longer when used intermittently. Since the inexpensive power source is self-contained, the spit can be used anywhere: around the home, in the yard or taken on picnics. The photograph at the top of this page shows the unit in action. Power unit, spit and two universal mounting brackets for attaching the unit to the grill of your barbecue are furnished as a package. Steak basket and a wheel that will hold six frankfurters are optional accessories. ★ ★ ★

Aluminum-Foil Lining in Grill Fire Pan Reflects Heat to Grid

Lining the fire pan of a portable charcoal grill with aluminum foil serves to reflect most of the heat produced by the coals to the cooking grid.

Also, the foil tends to provide more uniform distribution of heat for faster and better cooking of hamburgers, steaks and other foods. Heat rays that normally are absorbed by the bottom and sides of the fire pan are reflected back at all angles thus reaching the edges as well as the center of the cooking grid.

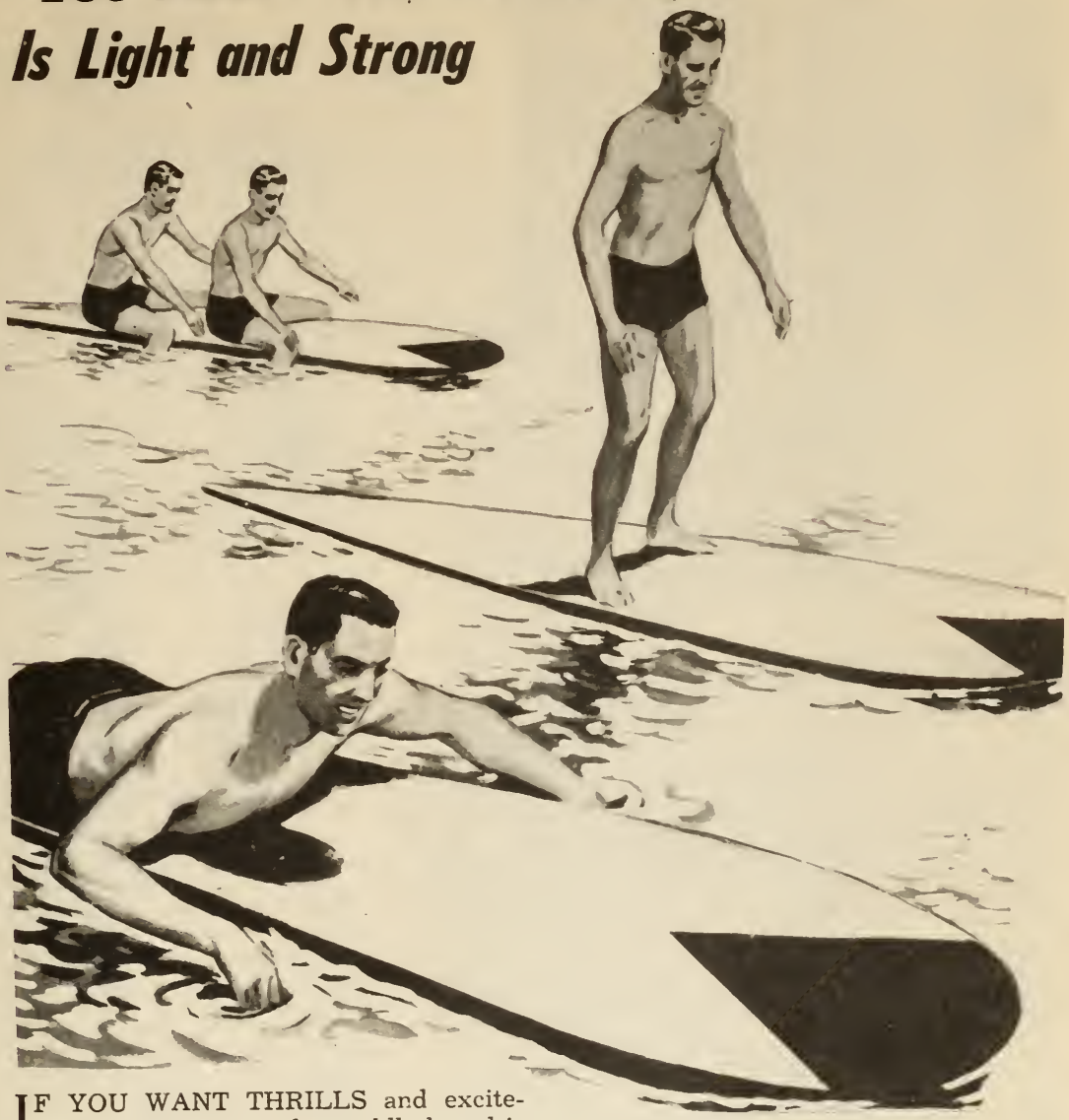


Midget Barbecue From Water Tank

When fired with charcoal this midget barbecue will cook as well as the larger ones. The fire bowl is the top of a hot-water tank. Three flat-steel legs support the unit. The grate is a wrought-iron screen supported on steel brackets. Several small holes drilled in the bottom of the fire bowl assure adequate draft. A welded-wire shelf provides a cooking surface.

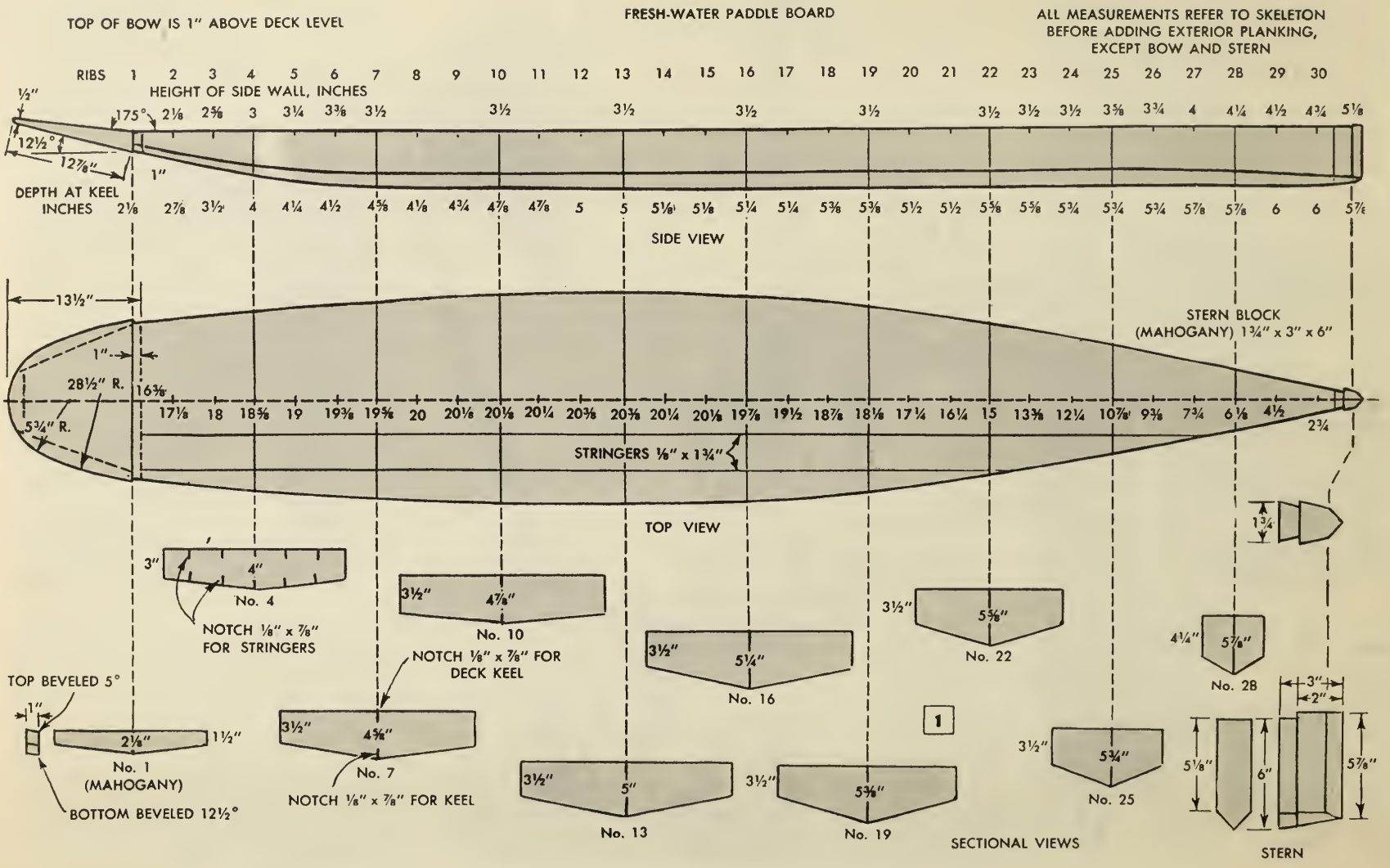
"EGG CRATE" PADDLE BOARD

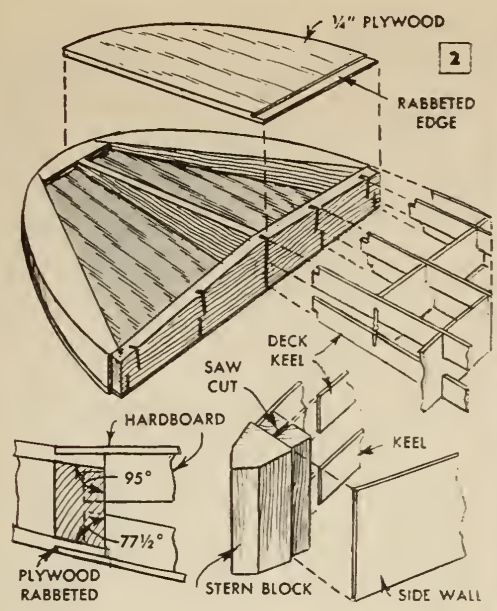
Is Light and Strong

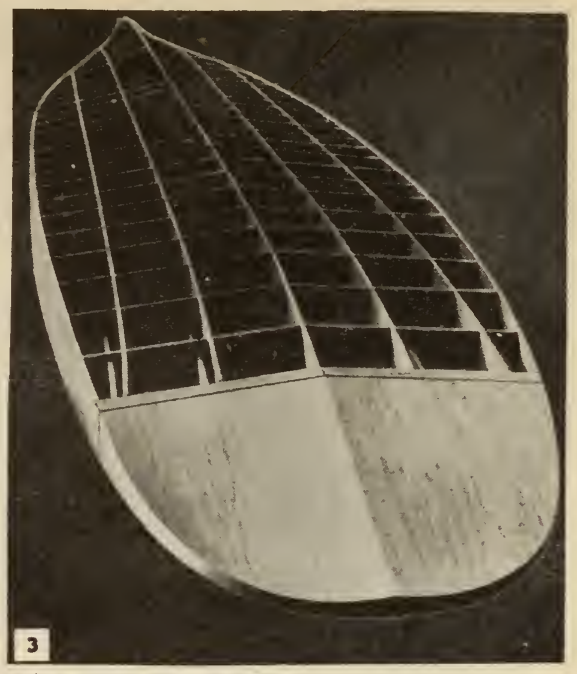


IF YOU WANT THRILLS and excitement on the water, this paddle board is for you. It will carry you along on the rushing crest of a breaker or let you skip through the wake of a speedboat towing you at full throttle. The board is equally good if you just want to paddle lazily around in a lake and sun-bathe. Safety, light weight and minimum maintenance are designed into the board to assure more fun and less work and worry. "Egg crate" construction is used to produce a board weighing one third less than a conventional type, with the added advantages of much greater strength and a one-third increase in weight-carrying capacity. A glass-fiber covering assures complete watertightness and minimum finishing problems.

Tempered hardboard ⅛ in. thick is used for all construction except the bow, which is made from solid stock and ¼-in. plywood, and the stern block that also is solid stock. Mahogany is suggested for some pieces made from solid stock, but since the finished paddle board is entirely covered, any good hardwood will do. Two 4 x 10-ft. sheets of hardboard are required in the construction of the board. Start by drawing the 29 ribs required on one sheet, using the dimensions shown in Fig. 1. Cut them out oversize with a handsaw, then trim to exact size on a table saw. Because of the need for accuracy when cutting the components of an egg-crate structure, a table saw is almost a necessity. However, an experienced craftsman, with much care, could do the job with a handsaw. Number each of the ribs, starting with No. 2. No. 1 is cut from wood. Cut a notch for the keel


TOP OF BOW IS 1" ABOVE DECK LEVEL
FRESH-WATER PADDLE BOARD
ALL MEASUREMENTS REFER TO SKELETON BEFORE ADDING EXTERIOR PLANKING, EXCEPT BOW AND STERN
RIBS 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
HEIGHT OF SIDE WALL, INCHES
½"
175°
12½°
12⅞"
1"
DEPTH AT KEEL INCHES
SIDE VIEW
13½"
1"
28½" R.
5¾" R.
STRINGERS ⅛" x 1¾"
STERN BLOCK (MAHOGANY) 1¾" x 3" x 6"
TOP VIEW
No. 4
NOTCH ⅛" x ⅞" FOR STRINGERS
No. 10
NOTCH ⅛" x ⅞" FOR DECK KEEL
No. 16
No. 22
No. 28
TOP BEVELED 5°
No. 1 (MAHOGANY)
BOTTOM BEVELED 12½°
No. 7
NOTCH ⅛" x ⅞" FOR KEEL
No. 13
No. 19
No. 25
SECTIONAL VIEWS
STERN





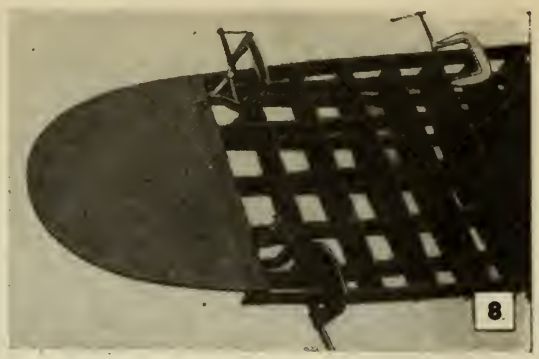
Above, bottom view of partly assembled hull shows bow, stern block, side walls and top deck in place

and deck keel in each rib, then stack the ribs and fit a strip of hardboard in both keel slots to keep the ribs aligned. Figs. 4 and 5 show the appearance of the stack from both bow and stern ends when it is clamped together. With the clamps in the position shown, cut slots for the bottom stringers. Because the ribs vary in height, cut the slots slightly deeper than ⅞ in. so the cuts in the narrower ribs will be closer to the right depth, even though slots in the deeper ribs will be too deep. On most of the shallow ribs, the slots later will have to be deepened still further to provide a correct fit. Because of the irregular shape of the stacked ribs, a jig of some kind will have to be used to support the work squarely and permit sawing. Note, too, that the slats for the stringers are offset slightly to let them bypass at rib No. 1. Next, fit two clamps over the opposite edges of the ribs, remove the other two clamps, then saw the stringer slots in the top edges of the ribs. These slots can be cut to the correct depth, as the top of the paddle board is flat.

Now, cut all stringers and both keels 1¾ in. wide and make the keels ¼ in. longer. Clamp them in a stack and notch them every 4 in. to a depth of ⅞ in. The keels and stringers can be test-fitted to make sure all notches are the correct depth, Fig. 6, before gluing is started. Use a good grade of waterproof glue and wipe the inside edges of all slots when assembling the egg crate. Install the deck keel and stringers first, then clamp in the stern block, detailed in Figs. 1 and 2. Turn the assembly upside down on a flat surface

Above, top and bottom views of stacked and clamped ribs. Note strips of hardboard in keel slots to keep ribs aligned. Below, slotted ribs and stringers are trial-fitted to assure proper fit before gluing

Rib No. 1 is cut from hardwood, slotted to accept ends of keels and stringers, then glued in place



Curved blocks for bow next are glued in place. Finally, plywood top and bottom are glued to assembly

and place weights on it to keep all pieces in proper alignment and contact. Make certain that the top edge of each stringer and the keel are flush with the tops of all ribs. After the glue has completely set, glue in the bottom stringers and keel, also placing weights on them to hold them in place until the glue sets.

Construction of the bow section of the paddle board, Fig. 2, starts with the making of rib No. 1, which is cut from hardwood. Note that the 2⅛-in. height of the rib is ¼ in. less than required at this point, to allow for the difference in the thickness of the ¼-in. plywood used to cover the bow, and the ⅛-in. hardboard used on the rest of the hull. A rabbet is cut in the plywood, as indicated, to accept the ends of the deck and bottom. The curved pieces of the bow frame are made according to the bow details in Figs. 1 and 2. Note that the bow frame is ¼ in. wider than No. 1 rib, where it attaches to the rib. This offset on each side allows for the ⅛-in.-hardboard sides and provides a flush joint at this point. As indicated in Fig. 2, a triangular-shaped center brace also is included in the bow section. The lower surface of this brace is beveled along each edge so that it will meet squarely with the two bottom pieces of plywood. Notches are cut in No. 1 rib to receive the top and bottom stringers and keels and it is glued in place. The bow pieces then are assembled and glued and the plywood top piece is glued and clamped in place, Fig. 8. When the glue has set, the bottom pieces of plywood are glued to the bow and clamped until the glue sets, Fig. 7.

The deck planking is next. Cut the deck from hardboard, making it ¼ in. oversize. Place the deck planking, bottom side up, on a flat surface, coat the top edges of all ribs and stringers with glue and invert the egg-crate assembly on the planking. Place weights on the assembly, making sure that all ribs and stringers contact the deck planking at all points. When the glue has set, cut two side pieces, making them ⅛ in. too wide. Coat the edges of the rib ends with glue and clamp the side pieces in place, allowing the ⅛ in. extra material to project below the bottoms of the ribs. When the glue has set, plane the edges of the deck so they are flush with the sides as in Fig. 3. Now, cut the two halves of the bottom planking and coat the inner surfaces of the planking and all inside surfaces of the partially completed paddle board with marine spar varnish or a vapor-barrier sealer. The bottom planks now are glued on, one at a time. Clamp them tightly to the sides and use weights to assure that they contact all ribs and stringers. When the glue has set, drill holes in the ends of the deck, sides and bottom planking and drive wood screws through these pieces into the stern block and No. 1 rib. Plane and sand all corners of the paddle board so they are smooth and rounded.

Application of the glass-fiber cloth is the final step. Place the paddle board with the deck side up, fitting wedges under the bottom to keep the board steady. Cut a piece of glass-fiber cloth large enough to fit over the deck and down the sides. Paint the deck with polyester resin, leaving a dry strip ⅜ in. wide along both edges. Start at the bow with the cloth and press it into the resin on the deck. Immediately paint both sides of the paddle board with resin, as well as the untouched ⅜-in. strip on the edges of the deck. Pull the cloth down over the edges and press it into the resin on the sides. The cloth folds readily over the edges as it contacts the resin, something it would not do if it had been saturated with resin before being folded. The resin sets up so rapidly that the cloth would have become semirigid by now if the ⅜-in. strip had not been left dry along the deck edges.

After the resin has completely set, invert the paddle board and apply resin and glass cloth to the bottom, allowing it to overlap the sides, bow and stern. This provides a double thickness of cloth at bow and stern for added strength. ★★★

Photos from U.S. Forest Products Laboratory and National Bureau of Standards Paint Manual

Better Results in Outdoor Painting

By E. R. Haan

IS THE OUTSIDE PAINT on your home cracked, blistering or flaking off? Unless you have put off a needed repaint job too long, such a paint failure may be due to premature old age. There are many causes for paint failure other than inferior paint and it will pay you to know about them in order to avoid such failures in the future. Then your next house-painting job can have a normal life cycle. Or perhaps you will find that immediate attention now will avoid a major job of removing all the old paint later.

Modern exterior paints. A good-quality paint made by a reputable manufacturer should last four or five years on the average home. This is twice the useful life of paints made 30 years ago. Modern paints are much more opaque and thus provide more covering ability than older-type

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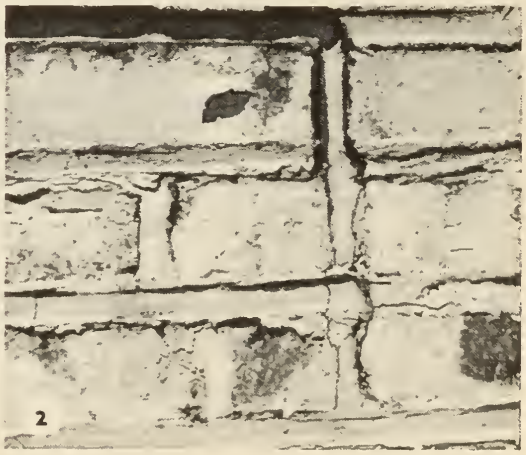

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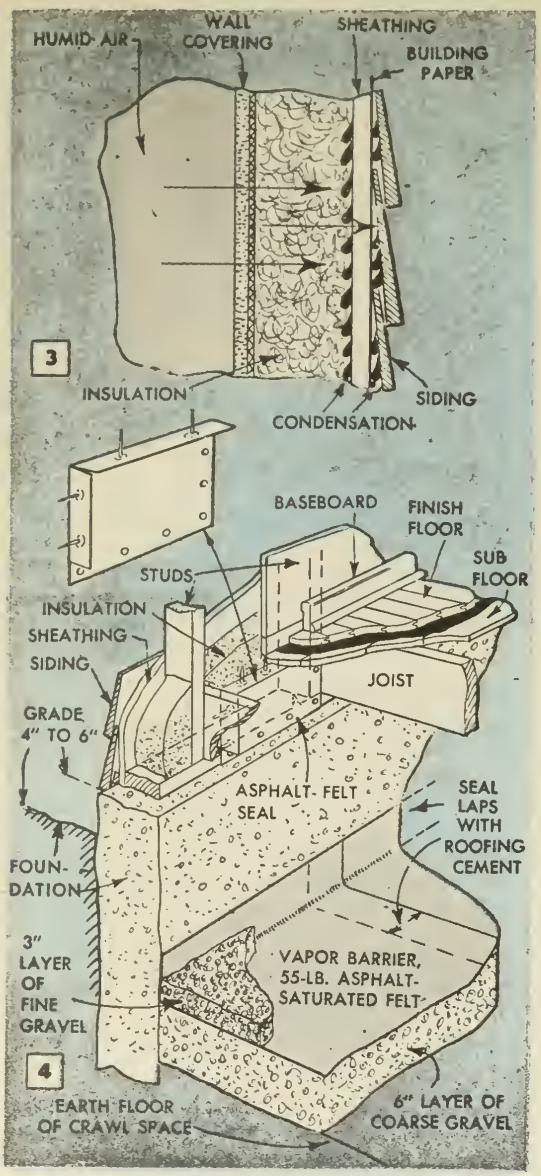


Below, unsealed spots over sappy wood and knots may alligator or peel. Seal them with aluminum paint

paints. White paints usually are self-cleaning, that is, the surface chalks off gradually in minute particles and washes away in the rain, carrying dust and dirt with it. Some white paints (titanium-zinc base) are fume resistant and are designed for industrial areas where fumes and gases cause early discoloration of ordinary paints.

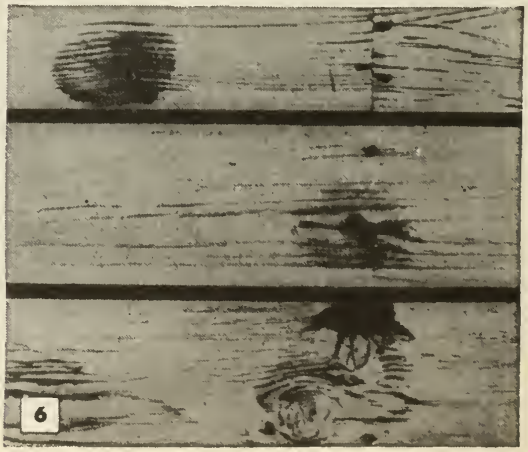
Most white and tinted outside house paints contain quantities of white lead, zinc oxide and titanium pigments. Colored house paints have other pigments and generally outlast white and tinted types.

A good two-coat paint job of today—which is equal to three coats of the older type paints—should consist of a primer and a finish paint. It is best to use a primer and finish paint manufactured by the same company and recommended for use together. Paints and primers made by different companies may have a chemical reaction which will ruin the paint job. Also, unless it is recommended by the manufacturer, do not thin a finish paint with linseed oil to provide a primer.

When repainting is necessary. Repainting is necessary at the first sign of deterioration of the old coat. Cracks, blisters, peeling, thin spots in the paint or mildewed areas all indicate that the surface should be repainted. As soon as the paint film cracks, water can get under it and loosen paint adjacent to the cracks.

If a coat of paint was properly applied, you will notice the first signs of failure on the south side of the house because of its greater exposure to sunlight. Horizontal or sloping surfaces such as window sills, steps and porch floors will deteriorate more rapidly than on vertical surfaces such as walls. On the areas exposed to the south and those which are horizontal, apply an extra coat or two of paint. The added protection will aid in giving the over-all paint job a longer useful life.

Even the best paints are often blamed for failures which actually are caused by



excessive moisture in the material painted, by mechanical defects of construction, by improper preparation of the surface and incorrect application of the paint.

Troubles from moisture. The most common cause of paint blistering and flaking is the presence of excessive moisture under it. This condition often is found on wood, Fig. 1, on brickwork, Fig. 2, and on concrete and stucco. Therefore, it is important first to make sure that the surface to be painted is absolutely dry and, second, that moisture cannot get into the painted material.

Excessive moisture in the air inside the house, especially in winter, is the greatest source of moisture trouble in outside paint. Water vapor readily passes through plaster and insulation not provided with a vapor barrier. Older houses which have blown-in insulation do not have a vapor barrier. The moisture from inside the house saturates the outside sheathing and siding, as indicated in Fig. 3, and the outside paint may loosen a few months after application.

The obvious cure for the problem is to reduce excessive humidity in the house. Exhaust fans in the kitchen and laundry will help. Moisture which rises from the earth in crawl spaces under the house can be controlled by covering the earth with a layer of coarse gravel over which is laid a blanket of 55-lb. asphalt-saturated felt, as in Fig. 4. Overlapping 4-in. joints are sealed with roofing cement. Openings in outside walls should also be sealed with felt. Dampness in basements and attics should be eliminated by suitable measures, such as ventilation or the installation of a dehumidifier.

The second step in controlling moisture in the house is to provide a vapor barrier on the walls themselves. This can be done by applying 2 or 3 coats of latex-base, or other moistureproof paints, on the walls and ceilings. Wallpaper can be applied over the paint, if you wish to use it in decorating. All cracks and openings at door and window frames, and even electrical outlets must be sealed to prevent the escape of moisture into the walls.

Outside the house, sources of excessive water are caused by leaking roofs, eaves troughs and downspouts. Also, wood that is in contact with the earth can draw moisture into the wall by capillary action. Any of these sources of water can be eliminated by proper maintenance and repair.

To dry wood siding that is to be painted, drive small wedges between the boards to temporarily permit air circulation. Dark mildew spots on paint indicate a high moisture content in the wood. A zinc-oxide base paint will retard mildew formation.

Failures from poor workmanship. Wrinkling of paint, especially on horizontal

The photo above shows the effect of painting a surface too frequently. A very thick coat is produced which may crack and peel, exposing wood to moisture

Paints applied must be compatible or cracking may begin within a few months. Above photo shows result of applying finish coat over incompatible undercoat. Below, wire brushing often reveals spots where paint is intact but has lost its bond with the surface. All such paint should be removed before repainting

Gutters and downspouts should be cleaned and repaired. Paint with roofing cement to preserve, patch

Calk all cracks along door and window frames and where wood meets masonry. Get compound in deep

surfaces, Fig. 5, often results from applying it too thickly and not brushing it out uniformly. Painting at a temperature of less than 50 deg. F., will cause this trouble because at this temperature the paint will not spread properly. Wrinkling also can result from painting just before a sudden drop in temperature. Consult a weather forecast before doing any extensive painting.

Thin spots in a paint job result from attempting to stretch the coverage by adding more linseed oil than necessary, or by brushing the paint out too thinly. To make thick paint flow more satisfactorily, add turpentine, not linseed oil.

Crawling and peeling of paint often shows if it is applied to a surface that is covered with a film of oil, grease or wax. This type surface should first be cleaned with benzine before it is painted. If a paint job has a soapy finish and seems to wash away readily in the rain, it may have been applied during cold, damp weather. Also, paint which contains a water-soluble pigment, or is made water soluble by a chemical action due to weathering, will wash off easily.

Blistering of paint may result from applying it on a surface exposed to the hot sun. The heat causes rapid evaporation of the vehicle or solvent, which bubbles up through the paint and prevents proper adhesion to the surface. Paint only in the shade on hot days. A further disadvantage of painting a hot surface is that the paint dries too rapidly to permit uniform spreading. Loose, blistering paint also may result from painting over loose spots of a previous job.

Yellowing of white paint, alligatoring and peeling in spots over knots and sappy wood, as shown in Fig. 6, may be caused by not sealing these spots with aluminum paint. Aluminum paint also prevents "bleeding" through the new paint by creosote or bituminous compounds in the old coat. Paint applied at intervals of less than three years—for the sake of appearance rather than protection—will produce a thick coat that may crack, as shown in Fig. 7. Checking of paint often is caused by allowing insufficient drying time between coats. At least two days should be allowed for a coat of outside paint to dry.

Paint failure caused by lack of uniform coverage frequently can be caused by incomplete mixing of the pigment in the vehicle. A good method of mixing paint is to pour off the surface oil into a clean, empty container and to stir the remaining paint until none of it sticks to the sides or bottom of the can. Gradually pour the oil back into the paint, stirring as it is done. When completely mixed, "box" the paint by pouring it from one container to another several times.

Incompatibility of paints. When repainting, use the same kind and brand of paint as the first coat, if it has given good service. Changing brands often results in paint failure, because the new paint is definitely affected by the old paint. In some cases, cracking and alligatoring, as shown in Fig. 8, may start within a few months, if the old and new paints are not compatible. Although this trouble is more frequently noticed when a white paint is applied over a dark color, it happens just as often when white is applied over an incompatible white paint. To make sure of avoiding trouble, use a primer and finish coat designed for use together.

Preparation for repainting. If a new coat of paint is applied to the outside of the

A regular calking gun makes the task of preparing the exterior for repainting easier and quicker

Old, cracked putty should be removed from windows and new putty applied before the repainting begins

house before the old coat has badly deteriorated, the job is fairly simple. Small areas of loosened paint should be scraped and wire-brushed and cracked boards and joints between boards should be calked with a suitable calking compound. Cement and brickwork also require calking at joints and seams. When the paint on the house is in an advanced state of decomposition, it is often necessary to remove all the old paint down to the bare finish. This can be done with chemical removers, by scraping and with a blowtorch. Electrically heated paint scrapers also are available. Mildewed areas and those streaked with dirt should be cleaned with a suitable paint-cleaning solution, rinsed with clear water, then allowed to dry completely before the new paint is applied. Areas of paint in good condition should be left, but slick or glossy spots should be rubbed with steel wool or sandpaper to provide a rough surface to which paint will firmly bond.

Nail down all loosened boards and drive in any projecting nails. Substitute slightly larger nails if the holes are enlarged. If rusty nails stain the siding, drive them below the surface with a nail set, and spot paint them. A day or so later when the paint has dried, fill in the holes with putty or calking compound.

Calking cracks. Calk all wood joints along door and window frames and wherever wood meets masonry. Be sure to get the calking compound deeply into the cracks instead of merely laying it on the surface. A regular calking gun does a quick, neat job and forces the compound into the cracks.

Where old calking compound has pulled away from the sides of a crack or joint, it may be necessary to break off and clean out the old calking. Cracks at mitered corners can be covered with siding corners. These are made of metal and can be painted to match the house. Fine splits and joints in a flat surface should be filled with putty applied with a putty knife; the calking gun would apply too much. Scrape off excess putty and allow it to dry a day or two before painting.

Clean all old cracked putty from window sash. Prime the bare wood and allow it to dry before applying new putty. The sash putty also should be allowed to dry a day or two before it is painted. The sash can be painted separately from the house wall, so the putty should not delay the job.

Painting time. The best time of year for painting is during the fall months when the temperature and weather are fairly constant. Begin painting at the highest point of the house and paint down in a 3-ft. band across one side of the house. Then, moving down for another 3 ft. strip., arrange your job so you stop at a window, doorframe or dormer, so that no definite vertical break will be noticeable. Paint the corners and trim boards first, if they are the same color as the house.

Summing up. Paint the house before the old paint has deteriorated badly. A good undercoat requires little or no primer, and one coat of good paint will cover and protect the surface. When the paint is allowed to become scabby, cracked or peeling, several days may be required to remove the old paint. Two or more coats of paint will be required to cover and protect the surface thoroughly, and all joints and cracks will need an excessive amount of calking.

Prepare the surface carefully, make sure it is perfectly dry and use only a good quality paint. ★ ★ ★

PAINT TIPS

Perhaps some of the tips on these pages will be new; others will remind you of ideas forgotten. For example, when you have three open cans of paint to carry, do you do a balancing act or make several trips? The fellow at the left shows how a wooden coat hanger solves that problem.

If you cannot find color you want, compound your own. First dissolve color-in-oil in small quantity of turpentine, then add to paint. Make enough at one time for complete job, to avoid any color variations

Punch holes in the rim of a newly opened paint pail with hammer and a nail or an ice pick. Paint caught in the rim then will drain back into the pail. When the lid is replaced it seals the holes

When only a small amount of paint is required, a 1-lb. coffee can makes an ideal container. Because it costs nothing it can be discarded after use, saving the job of cleaning. To make the can more effective and assure less mess, fit a piece of wire near the edge as shown. The brush then can be wiped against it, keeping all the paint inside

Even with holes in the rim to drain the paint some will remain and splatter when the lid is replaced on a pail and tapped down to seal it. Eliminate this problem by placing a cloth over the lid while hammering. Paper towels also can be used, or a couple of thicknesses of ordinary newspaper, any of which can be discarded immediately

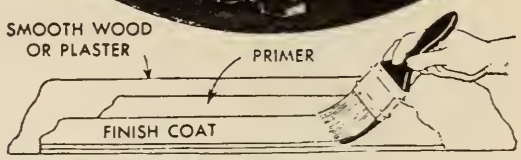
When paint has been stored for some time, any "skin" that has formed should be removed. Even more important, after the paint has been mixed it should be strained. A piece of window screening, cheesecloth or nylon stocking can be used as the filter material

PAINTING
Interior and Exterior

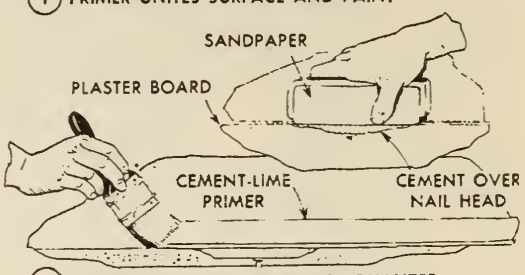
UNDERCOATING

SELECTING the right primer for any paint job depends upon the kind of paint you intend to use and the surface to be covered. As shown in Fig. 1, on a smooth, indoor wood or plaster surface, the primer acts as a seal over the work surface, and combines readily with the paint to form a uniform, even finish coat. If, however, the surface is made up of both hard, compact areas and rough, soft spots, such as are produced on plaster board when cemented areas over joints or countersunk nail heads are sanded smooth, Fig. 2, the primer must equalize the surface texture so that when painted the hard areas will not show as slick spots and the rough areas will not absorb the paint and appear as dull blotches. Where oil paint having a lustrous finish is used on such a surface, it is best to apply two primers, one consisting of a cement-lime ingredient to produce a toothy layer that will equalize the surface, and another made up of the proper base ingredients to unite with the paint. It is more economical to use two primer coats than to try to cover an imperfectly prepared surface with several coats of finish paint.

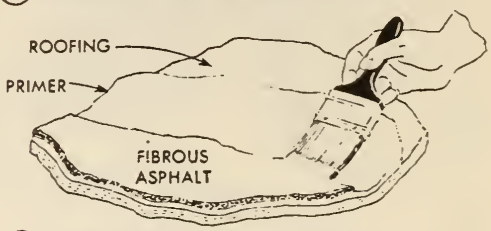
A primer used on dried-out composition roofs should be some nonfibrous asphalt liquid capable of resaturating the felt, after which a coat of heavy fibrous asphalt is applied, Fig. 3. Under heavy-bodied outdoor paints, primers having greater bonding strength than those applied on indoor work should be used. To gain this additional bonding strength, a primer must be able to penetrate the surface of wood or other porous material, Fig. 4. Therefore, it should contain penetrating and waterproofing oil. A satisfactory primer for metal surfaces must adhere firmly, be waterproof, and provide a suitable base for the finish paint. Also, it must have full drying time. Red lead and outdoor aluminum paint are commonly used over metals. If paint is applied before the primer has dried, the unevaporated, volatile content, sealed underneath by the nonporous metal, will be forced to penetrate the paint layer over it, Fig. 5.



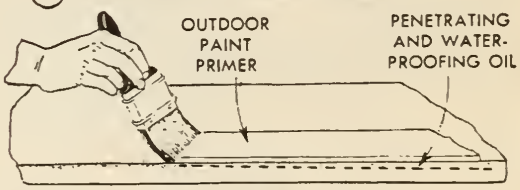
1 PRIMER UNITES SURFACE AND PAINT



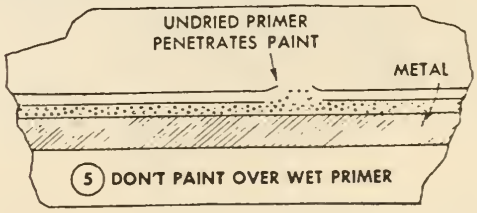
2 ROUGH AND SMOOTH AREAS EQUALIZED



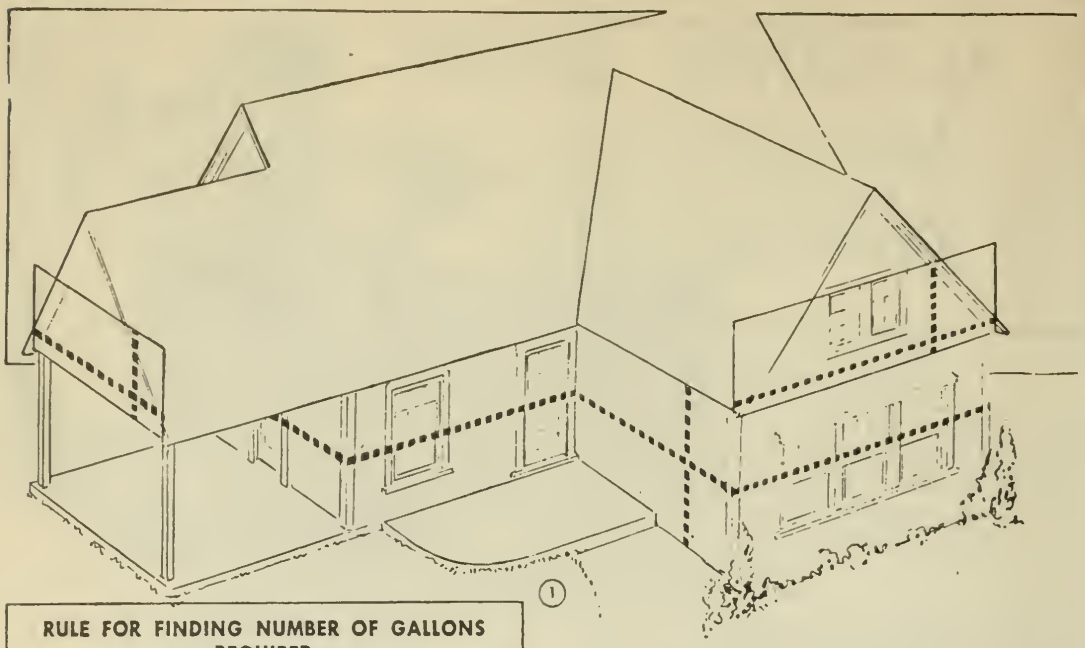
3 ASPHALT PRIMER FOR DRY ROOFING



4 OIL PRIMER WATERPROOFS WOOD

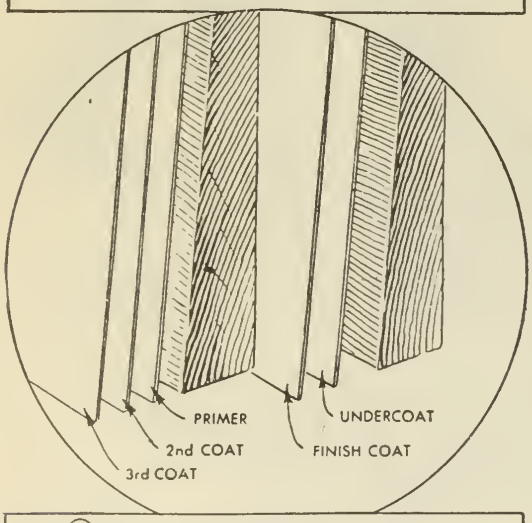


5 DON'T PAINT OVER WET PRIMER



① RULE FOR FINDING NUMBER OF GALLONS REQUIRED

Measure distance around house in lineal feet. Multiply by height to eaves. Divide by 600 where surface is in good condition—by 400 if surface is in poor condition. Measure width of gables and multiply by half the height

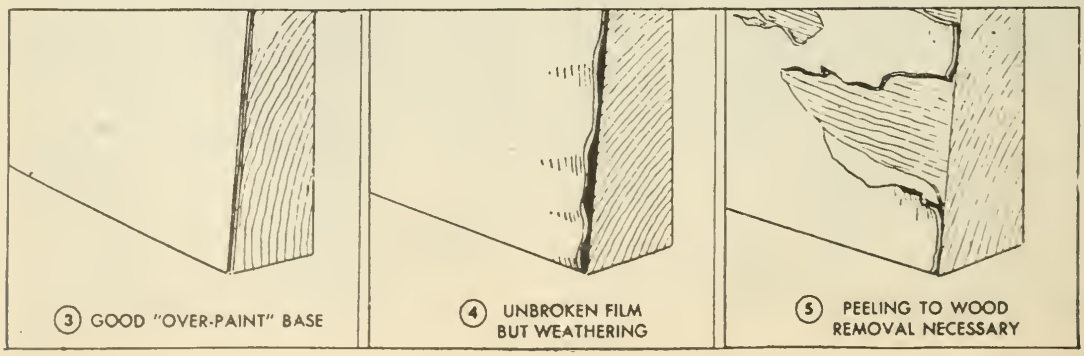


② TWO ACCEPTED METHODS OF PAINTING THE AVERAGE FRAME HOME

The result is a breakdown of the entire paint surface and a spoiled job.

Good paint will stick to almost any surface—for a while. How long it stays on is something else, for in the matter of durability it's what's under the paint film that counts. In general, the appearance of a house is not always a reliable guide to the condition of the surface over which paint is to be applied. Rather, adhesion of the paint film, original quality and formula of the paint and the condition of the building structurally are usually the factors determining the amount of work it will take to get the surfaces in proper condition for repainting.

Old paint worn thin by slow chalking and weathering—both normal processes—may appear to be in poor condition. But because of tight adherence to the wood and a solid bond between what remains of previous coating, it still will provide a good painting surface, Fig. 3. However, if the surface presents one or more of the defects shown in Figs. 4, 5, 10 and 11, which have been somewhat exaggerated for purposes of illustration, then the job of preparation



③ GOOD "OVER-PAINT" BASE

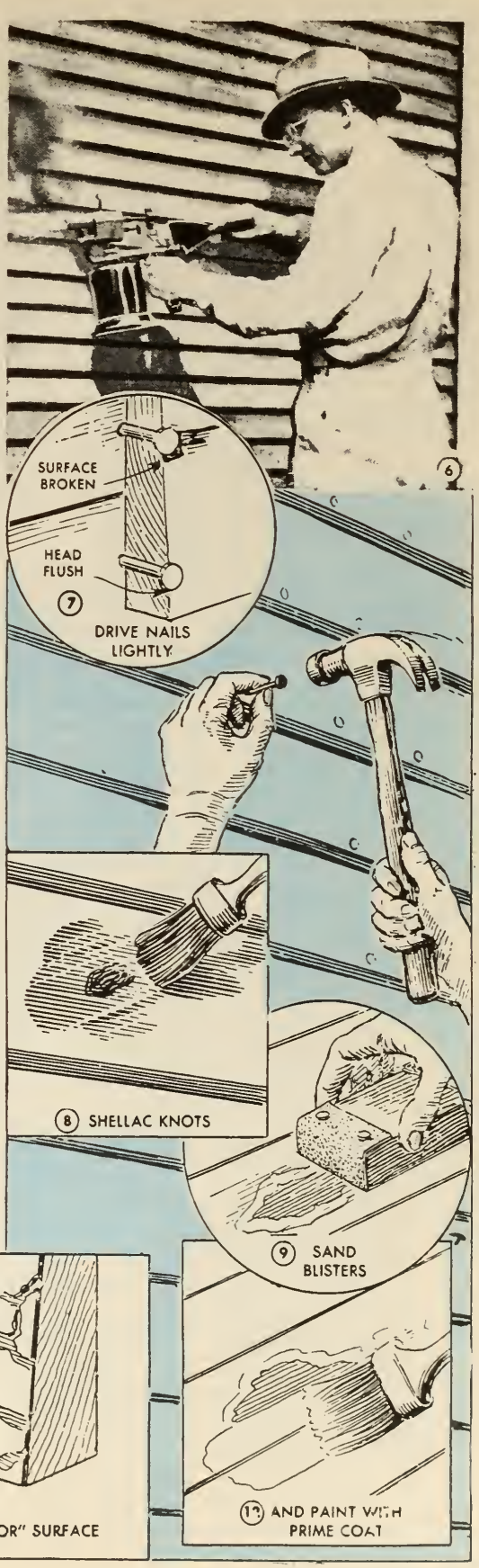
④ UNBROKEN FILM BUT WEATHERING

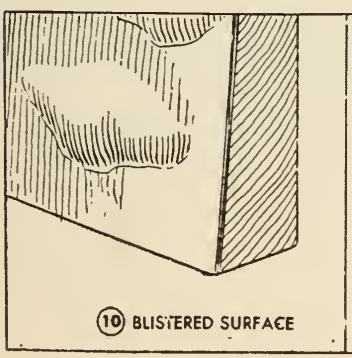
⑤ PEELING TO WOOD REMOVAL NECESSARY

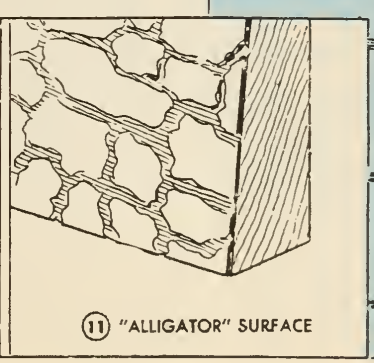
for repainting will be more extended. Scaling paint can be removed by scraping or wire-brushing, after which the surfaces are treated similar to new wood. But extensive blistering of the paint film and the peculiar "alligator," or "crackled lacquer," surfaces less frequently seen are among the most difficult of all defects to remedy. In most cases complete removal is necessary, but if a blistered area is small a thorough scraping and sanding to level the paint film which still adheres sometimes will suffice. Paint remover in the paste form also is effective on small areas. Likewise, the prepared remover may be used in cleaning off small spaces presenting cracked, chipped or alligator surfaces. It also is especially effective in cleaning up turnings, newels and ornamental work which frequently adorns porches and cornices of very old houses. However, where the area is large, such as a side or gable end of the building, burning off the defective paint film to the wood with a blowtorch, Fig. 6, is considered the best practice. Unless you are accustomed to the work it's best to get experienced help for this job. In any case, it's essential that the siding be tight, that the flame be directed against the surface at an angle and slightly downward, and that the torch be moved continually to prevent charring the wood. Follow the flame with a scraper to remove the softened paint immediately. And always work with the torch on a quiet day—never when it's windy.

The first coat of paint applied to any surface to fill the pores and form a hard surface is the primer. Priming must always be freshly made from pigments ground in refined linseed oil, paste driers and pure turpentine or mineral spirit. The priming solution is sold ready for use. The use of old flat paint (smudge), the aggregate of leavings from other jobs, as priming is unsatisfactory. The partially oxidized oil content prevents penetration of the surface and creates a film that is too elastic to withstand the surface strain developed by the aging of the superimposed paint.

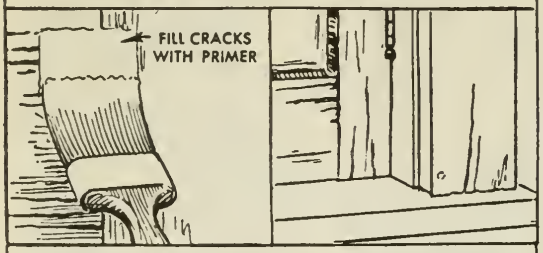
Fig. 2 illustrates two accepted methods



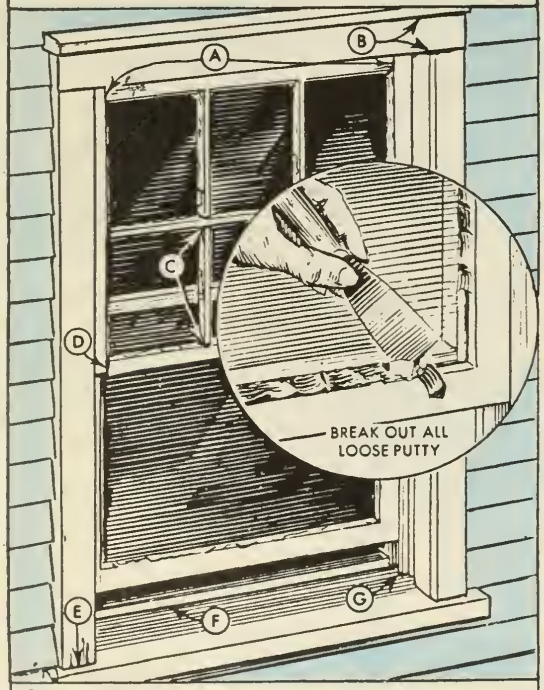




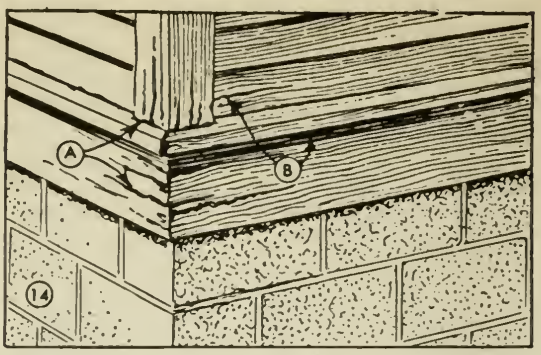
(13) Siding should be thoroughly wire-brushed to remove all loose pigment. Follow wire-brushing with a light dusting immediately before applying fresh paint to the surface



(15) End checks and cracks in trim boards, door stiles and rails, sash and window frames should be cleaned and coated with primer before filling with white-lead putty

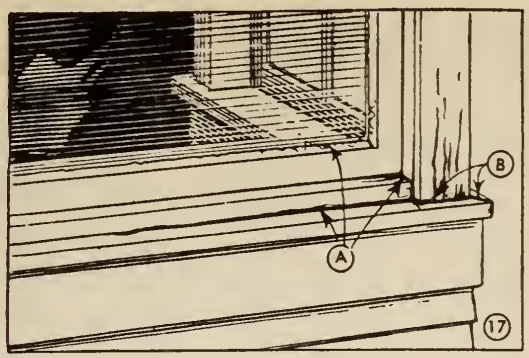


(16) Reconditioning old sash and frames preparatory to painting involves breaking out all loose putty, priming and filling cracks and checks, and in some cases tightening up the sash frames by nailing loose rails to stiles



of painting the average frame home—two coats over a primer, or one finish coat over a prepared undercoater. If you paint at intervals of less than four or five years the latter method is sufficient. But if the painting schedule calls for renewal only once in five years or longer, the three-coat job usually is recommended. Preparation begins with an estimate of the amount of paint required for the job. Unless the surfaces are in unusually poor condition this can be calculated with fair accuracy by means of the simple procedure and formula shown in Fig. 1. Of course, in using the formula other factors should be taken into account. For example, where there are more than the ordinary number of windows or glass-paneled doors, it is safe to deduct the area of the glass. "Cut-up" gable construction and varying heights to the eaves also will affect the accuracy of the calculation.

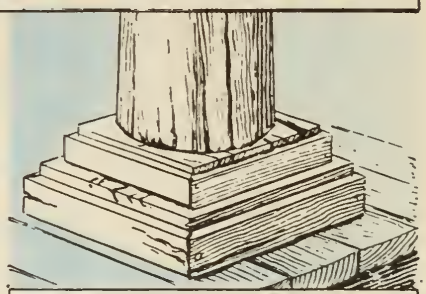
Next, where the house is of frame construction, the siding comes in for a thorough going over. Often it will be necessary to renail the siding, especially where it is exposed to weathering. Siding "cupped" outward between the studding calls for care in renailing. Use short, galvanized nails as these hold better when driven into the sheathing boards, and drill undersized pilot holes through the siding. Usually it's better to use two nails for each space between studs as in Fig. 7. Drive the heads flush, but do not sink them below the surface. After renailing go over all the siding, window frames, trim and cornices with a wire brush as in Fig. 13. This will remove any loose material that might flake off under the new coats of paint. It's a good idea to wear an approved respirator if you do much of this work. If any knots show through, sand off the paint and shellac as in Fig. 8. Some painters use spar varnish for this purpose. Any blistered spots where the paint chips off to the wood should be treated as in Figs. 9 and 12. Go over all sash and break out the loose putty as in the circular detail of Fig. 16. Conditions such as shown in Figs. 14, 15, 16, 17, 19 and 20 are quite common on the older houses. First clean the dirt out of all cracks and



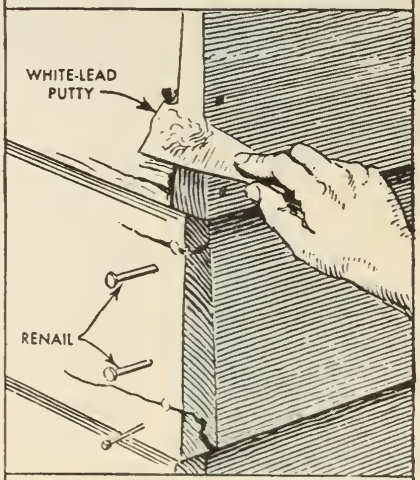
All spaces bared by removal of loose putty from sash should be coated with primer

openings of the kind shown, then apply the first coat of primer as it comes from the container, without thinning. Brush at right angles to the cracks as in Fig. 15 to work the paint well into them. At the same time coat all bared spots on the sash where old putty has been removed as in Fig. 18. After this paint coating is thoroughly dry fill the cracks with a paste white-lead putty, using a regular glazier's putty only on the sash. Paste white lead as it comes in the container usually will serve, but if it should be too soft it may be brought to proper consistency by adding a small quantity of whiting. It's important to fill the cracks completely, otherwise the putty soon will loosen and drop out. At this stage some master painters remove all outside doors and prime-coat the bottom edges, first making sure that the doors close easily without sticking. When applying paint in the manner described it's essential to brush out all excess to a thin film so that it does not show through succeeding coats. Siding boards which are lapped at the corners frequently warp and split and the end grain weathers badly in time. No amount of paint will hide this unsightly defect. Treat these corners as shown in Fig. 20, first renailing if necessary. Siding boards mitered at the corners sometimes warp slightly and pull apart, opening the joint. Master painters often gently pry these joints open far enough to fill the space with white-lead putty. Then renailing will tighten the joints once more to a neat fit. In any of these preparatory jobs where white-lead or glazier's putty is used it is of the greatest importance that the putty be allowed to dry thoroughly before paint is applied over it.

Fig. 16, details A to G inclusive, show the common defects one finds on old sash and window frames, particularly where intervals between paintings are longer than average. Frequently the lower rail will be loose, perhaps dropped partially at one or both ends due to opening of the joints and weight of the glass, as at D. In many cases this defect can be repaired by wedging the rail back into place and nailing through into the stile, using a single large finishing nail. Paint the cracks in the trim boards and fill with the lead putty as already described. Do the same with the sash frame where necessary, Fig. 17, A and B. Also, you may find small openings where the siding boards butt against the



(19) Cracks in old porch columns must be filled with white-lead putty before painting

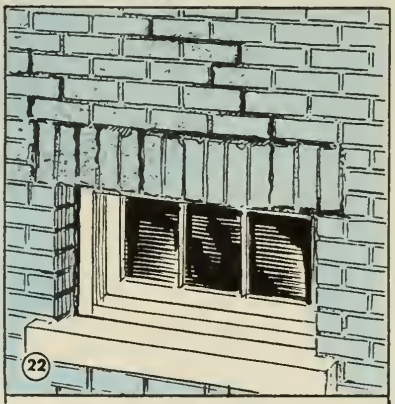


(20) Coat the end grain of corner-lapped wide siding boards with white-lead putty and renail the corners if it is necessary to close wide cracks

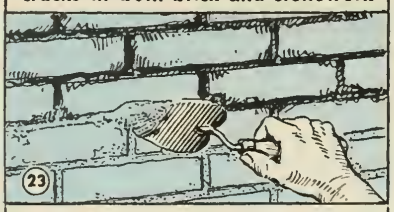
Usually it's best to remove sash for puttying as only small breaks can be repaired effectively with the sash in the frames

window frames or the corner boards, B in Fig. 14. Here's where the caulking gun comes in handy. Run a line of caulking compound into corner board and siding cracks and all around the window frames, also into the crack under the sill, as at A in Fig. 17. If the stops, G in Fig. 16, are loose, gently pry out the strip, prime-coat it and tap it back into place. Finally, putty the sash in the manner described, Fig. 21. In most cases, it is better to remove the sash from the frame for puttying, as it is easier to do the job properly with the sash flat and on a solid support. Smooth the putty into place with considerable pressure of the knife so that it will bond properly to both the wood and glass without any open spaces beneath. Open cracks usually will be found underneath boxed cornices, Fig. 27, and, although the wood is not subjected to weathering, the open cracks allow passage of cold air in winter and insects in summer. Fill with a caulking gun as indicated. If you find it necessary to seal the joint between a porch roof and the siding with roofing compound, Fig. 28, this should be done before painting. Such roofs should be flashed to the siding, of course, but in some instances it is easier to maintain the seal with roofing compound where flashing was not originally used.

Figs. 22 and 23 show two common defects, due largely to natural causes, which must be remedied before painting brick walls. Caulking around window and door frames of brick buildings is a regular practice and usually the caulking should run all around the frame, including sills and thresholds, Fig. 24. Frequently, rather fine, irregular cracks following the mortar joints will be seen in brick walls. Those shown in Fig. 22 are quite common and are generally due to settling. Usually caulking compound gunned into such cracks makes a suitable repair as it will remain semiplastic after drying and will not break out even though there be slight movement between the edges. It also effectively keeps out water and frost. However, if the crack is wider than ¼ in. the repair generally should be made by pointing up with mortar. Likewise, brick walls in rather bad condition, Fig. 23, with brick faces eroded and mortar crumbled out of the joints, should be pointed before painting. Buildings and homes of ornamental brick seldom are painted, but homes of all other types of brick—common, soft, pressed and de-aired—often are made more attractive architecturally and more durable by painting. Either the so-called white-lead-and-oil paints or the water-soluble paints made especially for outside masonry can be used satisfactorily on brick. The oil paint dries with a slight gloss on brick in good condition while the water paints dry with a flat, nongloss surface. Either paint is especially effective in "dressing up" old homes of brick. Except for the hard-pressed and de-aired



Caulking will effectively seal small cracks in both brick and stonework



Brick walls in badly eroded condition should be pointed with mortar before painting

Window frames in old brick homes must be recaulked before painting. Be sure that the cracks are filled flush with the surface

types, brick is porous and absorbs paint faster than most kinds of unpainted wood. For this reason the coverage per gallon on brick painted for the first time generally is considerably less than on any bare wood.

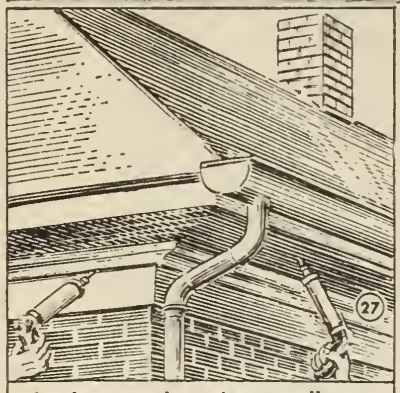
If the brick is in good condition and all common defects have been repaired as previously described, there need be little other preparatory work, except that on very old brick homes a light wire-brushing is helpful in removing dirt and loose sand. Sometimes there are discolorations beneath windows due to rusty screens, soot or dirt. Usually a thorough brushing with a handled wire brush will suffice. Discolorations due to other causes, such as mildew or "sweating" chimneys, should be treated with a zinc-sulphate solution or white asphaltum before painting. Follow the manufacturer's directions when applying any of these preparations.

Before painting brick with a water-soluble paint it generally is recommended that the wall be kept moist just ahead of the paint application. This can be done with a wheelbarrow sprayer, wetting only a small area at a time. A damp wall retards drying, making it possible to apply these fast-setting paints without brush marks or laps showing. On the other hand, when applying a lead-and-oil paint it is essential that the brick be thoroughly dry.

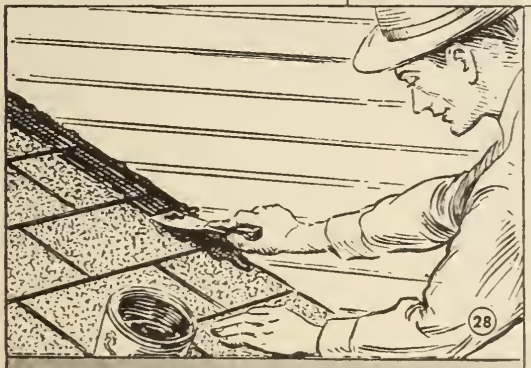
Two more points to think of before you paint are (1) the formula of the paint applied previously, and (2) how the paint you are to apply may change the appearance of the building. Using the lighter colors and white over a surface previously coated with a paint containing a tinting pigment of any of the so-called "earth" colors may under certain conditions cause "bleeding," that is, the darker color underneath may bleed through to the surface of the new paint, resulting in spotty discolorations. However, on old work in reasonably good condition where the previous paintings have been oxidized thoroughly, a good wire-brushing to remove all loose material down to the hard surface underneath and the use of a prepared undercoater is sufficient precaution against the possibility of bleeding.

Figs. 25 and 26 are an example of how painting sometimes changes the appearance of an old house, of either brick or frame construction. Note in this instance how certain constructional details have been almost completely hidden by the paint job, while other features, particularly the size of the house, have been emphasized. Generally the lighter colors, including white especially, will tend to make the house appear larger in its setting. It's always well to bear in mind that painting can be used to accentuate or minimize certain details of a structure as well as to preserve its surface.

"Before" and "after" views show how painting changes appearance



Cracks around cornices usually are best filled with a caulking gun. Be sure to force sufficient compound into the opening so that the soft material will bond to the wood



Joints between siding and roofs should be re-sealed with paste roofing compound before painting, or better, flashed to the siding if this was not done on the original work

Remove all loose, flaking and blistered paint with wire brush and scraper. Exposed wood is then primed

Above, before painting, dust is brushed from corners and horizontal surfaces where it always accumulates. Below, after loose putty has been removed and the bare wood primed, new glazier's putty is applied

PAINTING THE OUTSIDE

Painting the outside of the house provides the surface with both protection and decoration. As explained previously, the outside surface must be thoroughly cleansed of rust, dirt and grease. Old paint should be removed by burning off or by means of a liquid paint remover. Knots and resin spots in wood should be coated with knotting. After following the directions in applying the primer and treating the wood with filler, you are ready to apply the first coat of paint to the outside of the house. If followed through properly, there is no reason why the paint job shouldn't last for a few years.

Repainting the exterior of your home regularly every three to five years is the cheapest home repair. An unbroken film of paint protects the surface against weathering and against changes in temperature and variations in moisture content which cause swelling and checking of wood. Paint also discourages various fungus growths that flourish in the presence of moisture and cause rapid decay of siding and framing. A good paint job increases the appraisal value of the property as much as 10 percent by adding the beauty of durable harmonious color to both new and old homes. A little time spent in learning the proper painting procedures and how to wield a paintbrush with professional skill pays off in substantial savings to the homeowner who will tackle the job himself.

When to paint: Just when to paint depends on the local weather conditions but, in general, paint can be applied any time when the surface is dry and the temperature is fairly certain to remain above 50 deg. F. until the paint is dry. Avoid painting on hot, humid days or any time when a high wind is blowing as the freshly painted surface may become coated with dust and, in the summer, with small insects. The best time to paint a house is during a period of clear, cool weather, as the humidity usually is low and the drying conditions are ideal.

Selecting the paint: This depends to some extent on whether the building needs a one, two or three-coat job, and whether the first requirement is a full priming or only a spot priming after cleaning and dusting thoroughly. Manufacturers of paints now supply special primers, or undercoaters, for both new and old work which are especially compounded to "build" a suitable surface over which to apply a finishing coat. When preparing ready-mixed paints for use, pay close attention to the manufacturer's recommendations for reducing them to a brushing consistency. When undercoaters are used on old work on which the paint is in fair to good condition, one coat

of undercoater and one finishing coat usually will produce a first-class job. Master painters seldom use three coats except in some cases where it is necessary to remove all the old paint down to the bare wood or, in rare instances, where the color used makes a three-coat job necessary to build a paint film of sufficient body to hide discolorations or other surface defects. Very often one coat will be sufficient to produce a crisp, neat job over old paint of the same color.

How much paint: Although there are many factors which will determine the actual amount required for the job, it's easy to get a rough estimate of the number of gallons needed by figuring the number of square feet to be painted. Just multiply the width in feet by the height on rectangular areas. On the gables, multiply the width by one-half the height. Add the results and do not deduct for windows or doors. On a fair to good surface, a gallon of outside paint, or undercoater, will cover with one coat about 600 sq. ft. However, the coverage will vary from 450 to 750 sq. ft. depending on the condition of the surface. On a good surface, the coverage per gallon of the finish coat over an undercoater will probably average 750, and possibly 800 sq. ft. The undercoaters greatly extend the coverage of the finish coat even on surfaces which are in relatively poor condition for a finishing coat.

The undercoat is the layer of paint between the primer and the finishing coats. The function of the undercoat is to build up a substantial film to obscure the ground and provide a firm surface for the final coatings. In color, these coatings should be about the shade of the final covering. The undercoat must be applied with care, because careless brushwork cannot be covered later.

Preparing the surface: Chalking of paint is a normal weathering process unless, of course, the chalking is excessive. On a surface that is chalking normally, a slight rubbing on a small spot will produce a dull luster. If this condition is uniform all over the building a light dusting will prepare the surfaces for painting. On

Ca!king seals open joints where doors and windows join masonry. A gun applies it easily and quickly

FIRST BRUSH DUST FROM CRACKS

NEXT, APPLY PRIMING COAT

THEN FILL WITH "WHITE LEAD" PUTTY

the other hand, if bare patches of wood show here and there and if rubbing the surface fails to produce even a dull luster, wire-brushing will be necessary to clean the surfaces of fine, loose particles and flakes of paint pigment. Two coats will be needed to finish such a surface. If the old paint is broken by fine checks or has blistered and peeled rather badly, then more labor will be required to prepare the building for repainting. All the loose material must be removed by scraping and wire-brushing, Fig. 2. The rough edges of the paint film around the bare spots where blisters have occurred must be leveled by sanding and building up a new film by spot-priming. (Caution: It is advisable to wear a respirator when sanding, scraping or wire-brushing a painted surface.) Areas which are deeply checked by horizontal and vertical cracks—painters refer to this condition as an "alligator" surface—may either be sanded smooth or the paint removed entirely with a paint remover and the paint film rebuilt by prime-coating, followed by the regular undercoater and finish coats applied in the course of painting the whole structure. When preparing the building for repainting, examine the surface closely for the light-brownish discolorations caused by paint mildew. This is more likely to be found on old structures just above the foundation and under a wide cornice, and also on the siding back of large shrubs. The fungi, or molds, which are responsible thrive only in the presence of moisture and the cause should be removed before repainting. The dry mold can be removed by washing with household ammonia or with a solution of trisodium phosphate. Rinse with clear water after washing. All minor structural repairs, such as nailing loose siding, filling cracks and replacing gutters and downspouts which are no longer serviceable, should be made before repainting. Dust window sills as in Fig. 3 and prime and reputty old sash as in Fig. 4. Remove all the loose putty first, then prime the open rabbet before applying new putty. Fill cracks and nail holes, using the procedure pictured in Figs. 7, 8 and 9, with special white-lead putty consisting of 1 part white lead in oil and 2 parts of whiting by volume. This is softened to a working consistency with japan oil. Calk around door and window frames as in Fig. 6, using a gun and calking compound of gun grade. Spot-prime all areas where the old paint has been removed down to bare wood. Seal any exposed knots and resinous areas with orange shellac.

Brushes and equipment: For the average job you'll need a 1-in. sash brush, a 3-in. brush for doors and trim, and a 4 or 5-in. brush for painting the siding. Carry a dust-

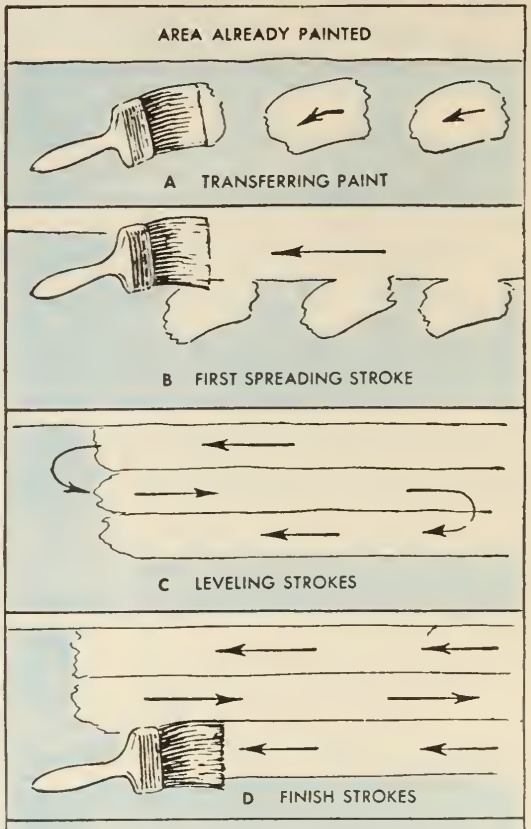
ing brush, a putty knife, a wire brush and a scraper. Ladders needed will depend on the size of the house, of course, but a step-ladder is essential and an extension ladder will be needed to reach the high gables. Usually, painting of the walls can be done faster and safer from a scaffold rigged with heavy planks and ladder jacks. The two sections of the extension ladder can be used for this purpose.

Mixing the paint: Both the undercoater and the finishing paint must be thoroughly mixed before using. Pour the paint from the pail into a larger container and stir with a flat paddle, adding reducer in small quantities as the stirring proceeds. To check the consistency, lift the paddle from time to time. When the mixture has been thinned to the proper brushing consistency, the paint on the paddle will run back into the container in a thin, steady stream which finally breaks into a series of drops. If the paint drips slowly into the container, it is too thick and will drag under the brush.

Where to start: As a rule, one should begin painting at the peak of the highest gable and work down as in Fig. 5. When working from a ladder, it usually is more convenient to bring the trim down on the high gables at the same time the siding is painted. Otherwise avoid working with two colors at the same time. When painting siding, begin at the corner board or, on gables, at the frieze board, and paint the lower edges first as in Fig. 10. Then lay the paint on the flat surfaces and brush it out by using the procedure detailed in Fig. 11, A to D inclusive. When painting siding, do not attempt to cover a panel more than five to eight boards in width. Finish this panel across the wall to a corner, or to a door or window before stopping. If you stop anywhere on the wall for more than a few minutes, the paint will set partially, making it impossible to brush out the lap when you begin again. This lap will show under several coats of any light-colored paint. It's a rule always to finish the panel to a corner or other suitable stopping place before you end work for the day or for other reasons.

Handling the brush: When working from a ladder at the higher levels, it's usually handier to paint above the ladder, as you can reach both ways and thus avoid the labor of moving a heavy ladder frequently. In handling the brush on long strokes, use a free and easy motion of the arm and wrist. The trick in lifting the brush off the painted surface without leaving a mark at the end of the stroke is to turn the brush slightly as it is lifted. This movement lifts the bristles with a wiping motion which does not leave a mark on the fresh paint film. Leveling and finishing strokes should overlap, details C and D in Fig. 11. Finishing

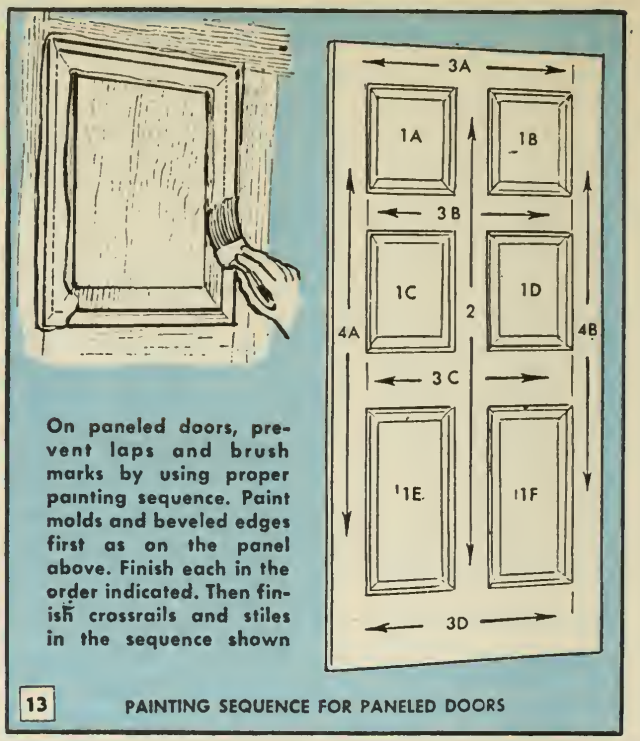
10



For uniform distribution of paint and the least spattering, first transfer the load from brush to surface with a few daubs, A. Then spread by right and left strokes, B and C. Finish with sweeping strokes as at D

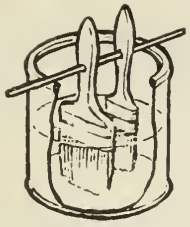
11

12



On paneled doors, prevent laps and brush marks by using proper painting sequence. Paint molds and beveled edges first as on the panel above. Finish each in the order indicated. Then finish crossrails and stiles in the sequence shown

13 PAINTING SEQUENCE FOR PANELED DOORS



A BRISTLES MUST BE SUBMERGED ENTIRELY

B PAINT CLEANED BY STRAINING

14

strokes should be light to avoid carrying the paint from one area to another, resulting in an uneven coverage. Each time the brush is dipped in the paint, slap the bristles against the side of the pail to remove the excess which may otherwise drip onto the siding below or onto the ground and be wasted. The first coat will require more brushing than the second, or finish, coat. Care must be taken to brush each coat to a uniform thickness. On buildings which have not been painted for a number of years the surface will absorb the oils in the first coat more quickly than will a surface which has been painted recently. Here, special care must be taken to prevent the undercoater from building too fast as it is applied, resulting in a heavy, uneven coating which may wrinkle or break up on drying. One way to avoid trouble under this condition is to cut down on the amount of paint picked up at each dip of the brush. Dust off the surface thoroughly just before applying the undercoat. On a good drying day, the paint in the pail may tend to thicken somewhat owing to evaporation of a small quantity of its volatile oils, especially toward the end of the day. Add a little reducer and stir occasionally to prevent this. Drying time allowed between coats should never be less than 48 hours. A week to 10 days is better.

Sash, trim and doors: Cutting-in sash, Fig. 1, with a paint either lighter or darker than the trim color requires skillful handling of the sash brush to produce a neat, workmanlike job. It is, of course, much simpler to paint the sash with the trim color, particularly on double-hung wooden sash where otherwise it is essential to cut a sharp color line at the point where the sash stiles and the upper rail meet the stops. When trim color is used this is not necessary. In either case, the first thing to do is lower the upper sash so that you can reach the outer side of the lower-sash check rail. On double-hung sash, this is always painted the outside color as it is exposed to view from the outside when the lower sash is raised. In painting divided-pane sash, cut in the muntins first on both the top and bottom edges. (The muntins are the vertical and horizontal bars which join the stiles and rails of divided, or multiple-pane, sash.) Keep the sash brush well loaded with paint so that it will stroke, or cut, a full-bodied line to an unpainted edge. Paint the sash stiles and rails and the window frames and casings last. If the sash have been scraped and sanded in preparation for repainting, it

will pay to apply an undercoater. This will build a good base over which to apply the finish coat.

The proper painting sequence on a paneled door is pictured in Figs. 12 and 13. If the door and frame are in good condition, about all that will be needed to prepare for painting is a thorough wire-brushing and dusting. Then proceed as in Fig. 12 and the left-hand detail in Fig. 13, by painting the ovolo molds and the rabbeted portion of the raised panel. The proper sequence is shown in the right-hand detail, Fig. 13. Begin with panel 1A and continue in the order indicated until panel 1F has been finished. Cut-in the molds and rabbets first, then finish the entire panel. Next, take the center stile 2 and follow by painting top rail 3A first, then 3B, 3C and 3D. Finish with the outside stiles 4A and 4B. On an outside door, paint the top and bottom edges. If the door swings out, the edge on the lock side also takes the outside color. The outside color line comes to the outside corner of the doorstop all the way around the frame on doors that swing out. On doors that swing in, only the edge to which the hinges are attached takes the outside color. The outside color comes to the inner corner of the stops. To get a neat, sharply cut line around the hinges and lock plate requires careful work. Often it will save time to remove the hinges and lock plates before painting.

Painting metal: Gutters, downspouts and metal porch rails should be carefully wire-brushed to remove scale and rust. If the gutters have been previously primed and painted and the coating is still in good condition, repriming will not be necessary. New galvanized gutters and downspouts should weather six months before priming and painting. However, iron grillwork and railings should be primed with special primers before painting in the color desired.

Paint and brush care: Keep all paint containers closed tightly when not in use. The paint in the container you use regularly becomes contaminated with dust and particles of dirt. Strain frequently into a clean container through a piece of cheesecloth or silk hosiery as in Fig. 14, B. To prevent paint on brushes from hardening overnight, hang them in water with the bristles submerged as in Fig. 14, A. If the brushes are out of use for a longer period, hang them in a solution of turpentine and linseed oil, equal parts. When the painting is finished for the season, clean brushes in two or three changes of turpentine, wash in a trisodium-phosphate solution and then in warm, soapy water. Before storing the brushes, rinse them thoroughly and, after drying, wrap them in oiled paper to protect the bristles from dust.

Selecting a brush: For wall painting, inside and outside, a flat wall brush is used. The professional painter usually prefers a long-bristle brush for the reason that it holds more paint, therefore requiring fewer dips to the paint pot, and enabling one to cover more square feet of surface per day.

The real value of a paintbrush is not in the kind of ferrule or the size and shape of the handle but in the bristles. Of course, a quality brush will have a handle designed to make the whole thing balance to a nicety and it will be shaped to fit the hand comfortably. The ferrule will be made to assure rigidity of the handle, but after all, the bristles do the work. A long-bristle brush will also last longer under steady, continuous service. For the amateur, however, a short-bristle brush is better, as one must be experienced in order to use the long-bristle brush. The former, if made of high-quality bristles properly balanced, will do good work and costs considerably less. Wall brushes are made in various widths from 3 in. to 5 in., the most popular being 3½ and 4-in. sizes.

For varnishing, enameling and lacquering, a flat varnish brush is ordinarily used. Most of the high-grade varnish brushes are made with a chisel or tapered edge, being so shaped to permit easier flowing of the varnish, enamel or lacquer. Flat varnish brushes come in different widths from 1 in. to 3 in., the width used depending upon the size and nature of the surface to be finished. For window sash, spindles, scrollwork, etc., the painter uses a sash brush—a small-size tool from 1 to 2 in. wide for working in close places, and a wider one for larger trim work. Sash and trim brushes are made with a long handle. Another type that should be mentioned here is the calcimine brush which is usually about 7 or 8 in. wide, with a sturdy handle. The important thing about calcimine brushes is their care. They should be washed in clean water immediately after using, the bristles straightened out, and the brush hung up by the handle to dry. The calcimine brush should never be used in oil paints. Careful painters always use a dusting brush for cleaning dust, cobwebs and soot off the surface before painting. Dusting brushes are made in the same general way as the ordinary paintbrush, but with finer bristles, and are available in both flat and round styles. You'll find it's good economy to keep several brushes on hand and use separate ones for painting, varnishing, lacquering and enameling. If, for example, you use a varnish brush for paint, it will be impossible to clean it satisfactorily for use in varnish again, no matter how carefully it is done.

Taking the Guesswork Out of INTERIOR PAINTING

How to select and use the right paint for the job to avoid common painting failures. Includes data and recommendations for preparing surface, applying deep colors

HAS THE do-it-yourself painting bug bitten you yet? It's possible you already are one of the great army of amateur brush swingers who are buying and applying over two thirds of all the paint being sold. While modern paints have taken the word *skill* out of painting for both Mr. and Mrs. Homeowner, many beginners blithely apply one coat over another without giving too much thought to the importance of proper surface preparation and the right paint for the job. Such mistakes as applying enamel over one coat of flat paint, or over a waxed or old calcimined surface have been made by many amateur painters with unhappy results.

Follow reputable dealer's advice: As there are many brands of paint that vary in formulation, quality and purpose, the job of selecting the right one becomes somewhat confusing. However, after deciding to avoid cheap, questionable paints and to use only those of high quality, the problem simmers down to relying on the advice of a reputable paint dealer. His suggestion will depend on what you are going to paint, the condition of its surface and other considerations as given in the chart at the left.

What's in a can of paint? A little knowledge of paint formulation, know-how of painting procedure and the ability to differentiate between various kinds of paint can put you on the right track if you don't want to accept the word of a paint dealer blindly. In a broad sense, paint refers to any liquid coating brushed, rolled or sprayed on surfaces to protect them and to enhance their appearance. In a more restricted sense, paint differs from enamel, varnish and lacquer because of the ingredients used.

Paint in the restricted sense consists of two main ingredients: 1. A pigment or combination of pigments which produces opacity or hiding power. In oil paints the pigments include lead, zinc, titanium, iron and others. 2. A liquid binder (also called

1. **What is to be painted?** Can be plaster, wood, wallboard (dense or porous), paper, fabric, metal, concrete or masonry (dry or damp).
2. **Is surface bare or finished? If finished, with what?** Can be water-reducible paint (casein, resin or rubber base), one-coat flat, finish paint or enamel, varnish, lacquer, penetrating varnish sealer, oil, wax, bituminous paint (on soil pipes), etc.
3. **What is the condition of the surface?** It may be flaking, blistering, wrinkled, cracked, alligatored, badly marred or show bleeding of prior surface.
4. **Is surface subject to excessive heat or dampness?**
5. **Has surface been prepared for repainting and how?**
6. **What color, shade and degree of sheen?** Do you want flat, eggshell, semigloss or gloss?

Many painting failures can be avoided by getting and following the advice of reputable paint dealer

vehicle) which holds the pigment together at a uniform density and forms a film after it has dried. Thinners and driers are added to binders in certain proportions to obtain the right consistency for application and to hasten drying. Oil paints have an oil binder such as linseed oil, soybean oil, tung oil, castor oil and others. Thinners for oil paints include turpentine, mineral spirits and varnish maker's and painter's naphtha.

Water-reducible paints have binders such as glue, casein, protein, resin, oil or latex (rubber) and are thinned with water. As the last three ingredients are in themselves not water-reducible, an emulsifying agent is required to make them so. Water-reducible paints for waterproofing concrete, which contain portland cement in addition to pigments and chemicals, come in dry, powder form. Calcimine consists of chalk and glue in powder form and is dissolved in water.

Varnish consists of an oil and resin solution with thinner and drier added. Varnish stains have some pigment. Enamel differs from oil paint in that it consists of a pigment in a varnish-type binder. It surpasses oil paint in toughness, hardness and resistance to acids and alkalies. Some varnishes and enamels are resistant to alcohol. Enamel may be dull, eggshell, semigloss or gloss.

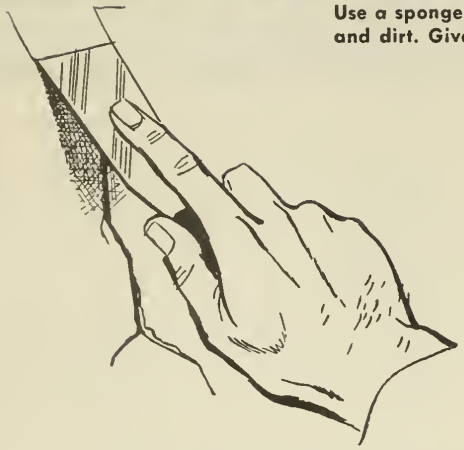
Lacquer serves the same purpose as varnish and enamel but dries faster and usually produces a thinner film. The principal ingredients of lacquer are cellulose nitrate (guncotton), resins, plasticizers and volatile solvents such as butyl alcohol. Adding pigment to this combination produces colored lacquer.

Types of paint as to purpose: As to their purposes, paint products can be divided as follows: 1. Sealers, also called primers or primer-sealers. 2. One-coat flats. 3. Finish paints, enamels and varnishes to be applied over sealed surfaces. 4. Water-repellent concrete paints. Since paints vary considerably with the use of synthetic resins, pigments, chemically processed drying oils, etc., they require different handling as to thinners, drying time between coats and solvents. Therefore, the importance of following explicitly the manufacturer's instructions on a can of paint cannot be overemphasized.

One of the most common errors in using paint is to neglect stirring it thoroughly so that all the pigment is uniformly suspended in the liquid. Also remember that oil paints should never be applied to damp or wet surfaces as they will not adhere to them. Thinner should be added to paint only in accordance with a manufacturer's instructions, and only the correct type of thinner should be used. For example, to thin water-reducible paint you use water, not turpentine.

Sealers on bare, porous surfaces: Bare plaster, wallboard and wood surfaces require a coat of primer-sealer and this must

Use a sponge dipped in household cleaning solution to wash off grease and dirt. Give solution time to work, then wipe wall with clean water



Plaster cracks should be filled before painting with Spackle. Trowel marks should later be sanded smooth

be allowed to dry thoroughly before applying a succeeding coat of finish paint or enamel. Primer-sealer prevents absorption of the binder from paint, which would prevent the paint film from acquiring its desired thickness, hardness, toughness, durability and uniformity of color and sheen. Although shellac does an excellent job of sealing, it creates a surface that is extremely difficult to paint.

Many sealers belong to the varnish family and penetrate porous surfaces only slightly. They may be pigmented or clear. Many sealers are white and can be tinted to the approximate color of the finish coat. Often this is done by adding not more than one part of the finish paint or enamel (made by the same manufacturer) to two parts of the sealer. Water-thinned sealer is tinted with water-reducible colors but not with any color in oil. Some sealers are for use on walls primarily, some are especially for wood, and others for both. Some sealers are designed for exceptionally porous materials such as soft wallboards. Others are supplied in more or less concentrated form requiring the addition of suitable thinner in certain proportions for surfaces of different porosities, as usually is explained on the can.

Plaster surfaces should be suitably prepared before sealing them, by filling cracks with crack filler or Spackling compound. Trowel marks and other surface projections should be sanded down. Large cracks must be undercut and filled with patching plaster. Such repairs are spot-sealed and the sealer allowed to dry before sealing the entire surface.

After sealer has dried it should produce a uniform sheen. Any flat spots should be recoated. Sealers of the varnish type usually require overnight drying, although a recently developed water-thinned sealer dries so fast that a finish coat can be applied as soon as the circuit of a room has been completed, which is of special advantage to week-end painters. This sealer also bridges hairline cracks, thus eliminating the need of filling them.

Close-grained wood requires only a coat of sealer before painting but open-grained wood must be filled with a suitable paste wood filler. This is wiped across the grain and the surplus removed. After the filler has dried from 18 to 24 hours, the surface is sanded smooth using No. 0 sandpaper. Then the surface is wiped clean and sealer

is applied. When dry, the surface is sanded and cleaned before applying the finish coat.

Conditioning painted surfaces: Painted walls and woodwork must be conditioned for repainting. First clean off all traces of oil, grease, wax, soot and dirt, using a household cleaning solution. Apply this with a sponge, allowing enough time for it to dissolve the dirt and oil film before wiping it off with a sponge moistened with clear water. Always start at the bottom of a wall and work up, as this prevents unsightly streaking caused by the solution running down over an uncleaned surface. Calcimine can be removed with plain, hot water. Glossy enamel to be repainted should first be made dull by a cleaning solution of adequate strength, or by using fine steel wool. A dull surface anchors the new paint better than one that is glossy. Cracks also should be filled as previously explained.

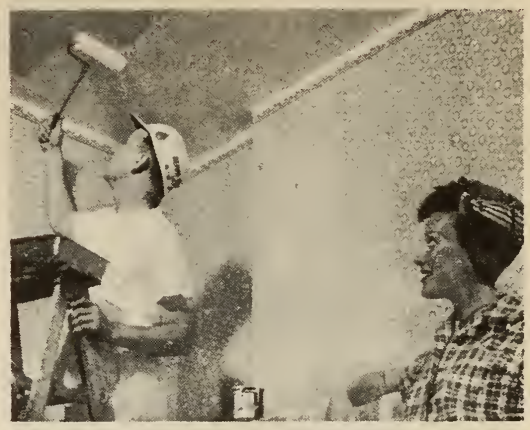
Remove all loose, flaking and blistered paint with a scraper, putty knife, No. 0 sandpaper or fine steel wool, tapering the edges of the surrounding paint film. Then seal the spots. Wrinkled paint films, caused by too thick a coat of paint, are removed with paint-and-varnish remover. This is brushed on and allowed to soften the paint before removing it with coarse steel wool. Then all traces of the remover are eliminated by washing with turpentine or benzine.

If a surface to be painted with oil paint or with enamel is covered with a one-coat flat paint, a sealer should be used. Under a microscope such paint resembles a sponge, and will absorb the binder of paint subsequently applied. Then, although the new coat of paint may appear satisfactory, it will be impossible to wash clean.

Where oil paint or enamel is to be applied over a coat of casein paint, it should be removed as much as possible by scrubbing with hot water. After the wall is dry, a suitable sealer then is used before the desired finish coat is applied. Resin-emulsion paints to be so covered need not be removed before redecorating, but a coat of sealer is needed. Rubber-base paints usually provide an impervious surface and serve as a sealer for a subsequent coat.

Where deep-tone colors are to be used, it is especially important to seal a previously painted wall. Without effective sealing deep-tone colors invariably show light and dark spots. Where such trouble occurs the only remedy is to reseal and repaint. An added coat of deep-tone color directly on the first coat only aggravates the condition.

One-coat flats: When walls must be covered for appearance at minimum cost, you can use a one-coat flat paint, which is a combination sealer and finish coat. Most water-reducible paints also serve the same purpose. Generally a one-coat flat paint is not as washable as an enamel. A one-coat flat should never be used as a sealer since it renders the subsequent coat less washable. Often one-coat flats are sold in paste form and thinner is added in accordance with the manufacturer's recommendations.



Above, ceilings are always done before the walls. Below, deep-tone colors must be applied evenly to produce a uniform coating. Here a good-quality lamb's-wool roller should be used to apply the paint. Note that a brush has been used first to cut-in around doors and windows, and along ceiling line

Finish coats over sealer: Paints of the lowest gloss generally have the most hiding power and vice versa, although some modern gloss enamels do have remarkable hiding power. Paints of low gloss are usually preferred for living and dining rooms, dens, hallways and bedrooms. Semigloss and gloss enamels are usually best for bathrooms, kitchens, laundries and utility rooms as they are tougher and harder, and will therefore withstand washing more readily. Generally the higher the gloss the more washable the paint is.

The hiding power of enamels also varies with different colors and shades. For gloss

Regular sash brush makes window painting go fast. Masking tape may be used to keep paint off glass

In painting paneled doors, coat the molding and panels first, then do the rest. Brush with the grain

enamels of relatively low hiding power, you can tint the sealer or apply a coat of flat or eggshell enamel of the same color before applying the finish coat. Some manufacturers provide a gloss builder which when added to flat enamels makes them glossy. A gloss builder also tends to deepen the color and makes the enamel thinner, which reduces its hiding power. Gloss builders should be used only in enamel made by the same manufacturer. Also available are "modifiers," which reduce the gloss of enamels. Lacquer should never be applied over an oil paint or over an enamel as the lacquer binder dissolves the old coat, resulting in a ruined finish.

Deep-tone flat paints, when washed, are likely to develop shiny spots caused by the friction of rubbing. This also occurs with light-colored flat paints but is less noticeable. Since a uniform coating of paint is especially desired when applying deep-tone colors, it is best to use a good, lamb's-wool roller. A brush is used for cutting in along edges of trim and at corners, and ceilings are always done before walls. Walls are painted from the top down. A 3-in. brush is used for trim, a regular sash brush for window muntins. On paneled doors, the panels are painted first.

Water-reducible paints: Some water-reducible paints are used as purchased in the can while others come in paste form and must be mixed with a specified portion of water by the user. Some are flat and others have varying degrees of gloss. Most of them can be applied directly to bare plaster or to painted plaster without the use of a sealer, but for others a sealer is sometimes recommended. Those employing casein or protein binders are often referred to as "washable calcimines," but they are less washable than resin or rubber-base paints and regular enamels.

Casein paints should not be applied to walls that are continually damp nor in places where high-humidity conditions may occur, especially in warm climates, as the paint may mildew. Water-reducible paints generally harden to the touch in about a half hour, and a second coat, if necessary, can be applied in two to four hours. However, they develop their maximum toughness after drying for several weeks, after which they can be washed. As a rule, water-reducible paints are used for walls but not advised for woodwork, particularly if it is subject to scuffing or handling and must be repeatedly washed.

Painting over wallpaper: Water-reducible paint may be applied over wallpaper if it is well bonded to the wall, does not contain dyes that might bleed through the paint, and if there are not too many thicknesses of paper—only one thickness is best to facilitate later removal. Where casein and resin-emulsion paints are so used, it is possible to remove the paper by steaming, but where rubber-base paints are applied the task of removing the paper becomes very difficult.

Texture paints: Plastic paints of both the oil and water-base varieties contain heavy-bodied materials and are used for textured

effects. They are especially useful for covering walls scarred by previous patching. After the paint has been applied and before it sets, designs are worked into the surface by brushing, stippling and troweling, or other means. Since most texture paints set rather quickly, windows and doors of a room in which they are used should be closed to avoid too rapid drying until after the surface has been textured.

Drying time of paint: When paint is applied at a temperature from 60 to 75 deg. F., you can be quite sure that the drying time will correspond to that usually indicated on the can, except on very humid days. Lower temperatures lengthen drying time and higher temperatures shorten it. The latter causes the paint to set faster and may cause it to drag under the brush and become "ropy." Fast drying can be retarded by adding some thinner of the proper kind to the paint. High humidity often retards the drying of paints as much as days. Therefore, if possible, clear, dry weather should be selected for painting jobs. ★ ★ ★

Photos courtesy Sherwin-Williams Co. and Pittsburgh Plate Glass Co.

Utilizing All Pigment Assures Identical Paint Colors

Using every bit of coloring from the tube is the secret of exactly duplicating a color when tubes of coloring are mixed with a base paint. To do this, slit each tube of coloring with a razor blade while it is held over the container of paint. Then, after all the coloring has run out of the tube, drop it into the container and mix the paint thoroughly. When the tube is removed, it will be clean of color, the paint solvents having removed it while the paint was being mixed.—R. J. Ahrens, Somerville, N.J.

Paint in Nail-Polish Bottle Used to Touch Up Scratches

Next time you finish painting, save a little of the leftover paint in a clean nail-polish bottle. When chips or scratches show up in the painted woodwork or walls, simply apply paint from the bottle with the self-contained brush. The bottle and brush can be cleaned of nail polish by soaking them in ordinary lacquer thinner.

Preventing Paint Accumulation In Heel of Brush

It is much simpler to prevent paint from accumulating in the bristles at the heel of a brush than it is to remove the paint after it has hardened. A simple preventive measure is occasionally to squirt solvent from an oil can directly into the bristles next to the ferrule while the brush is being used.

Ken Murray, Colon, Mich.

HALTING FIRE

By Paul W. Kearney

Hon. Life Member, International Association of Fire Chiefs
Author of "Disaster on Your Doorstep"; and "I Smell Smoke"

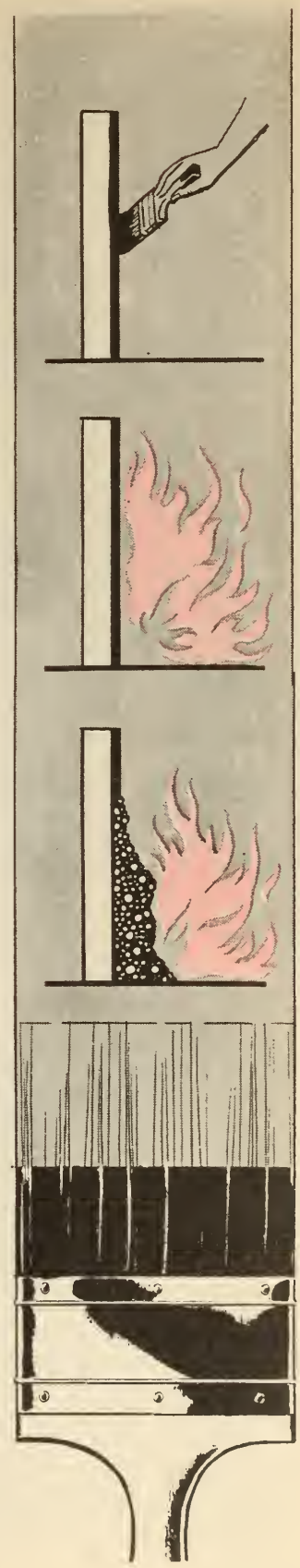
LAST DECEMBER in a Richmond, Va. residence a fire started in an overstuffed sofa some hours after a Christmas party had broken up. Once under way, the flames spread rapidly up an open stairwell, cutting off the exits at each end of the upper hall. Final toll: Five dead; the house a total loss.

In contrast to this tragedy, consider the incident in a Fresno, Calif. Veteran's Housing development where another live cigarette butt fell out of an ashtray onto another sofa after the GI and his young wife had gone out to the movies. Fiberboard walls and ceilings had been extensively used in this project. While the blaze which spread from the sofa lasted an estimated 40 minutes, consuming every stick of furniture in the room, it never got out of the apartment to sweep through the rest of the building—it didn't even damage the electric wiring in the walls or ceiling. It

. . . but it could save your life

The finest fire-retardant paint cannot prevent a fire, extinguish a fire or withstand a severe fire indefinitely. It cannot make anything "fireproof." But it can reduce the combustibility of the surface to which it is applied for a reasonable time. This can be time enough to get out of a burning building or time enough to do something about the outbreak before the fire gets completely out of hand.

Fire-retardant paint is activated like a sprinkler system. When the temperature reaches 400 to 500 deg. F., the intumescent agents in paint start to swell and form a cellular barrier which insulates the wood and other combustible surfaces underneath. This insulating barrier reduces excessive heat penetration and retards the spread of flame



WITH A PAINTBRUSH

simply died from lack of sufficient nourishment when all the available fuel in the room was exhausted.

The big difference between these two fires was no bigger than a paintbrush. For while an unprotected open stairwell spread the first outbreak with tornado velocity, it wouldn't have taken the second blaze long to eat its way out to an even more extensive stairwell if it hadn't been confined to its point of origin by an effective fire-retardant paint.

Most householders are unaware of the existence of such protection—and for a good reason. Most manufacturers sell all they can produce to industrial, commercial and government users, hence aren't too concerned about the retail market. Since early in World War II, the Army and Navy have been using a brand that has been listed by the Underwriters Laboratories for some 20 years. Now the current UL (Underwriters Laboratories) list includes eight other "surface coatings" which can be brushed or sprayed like ordinary paint and are available to the householder.

Describing these coatings in general, the Paint, Oil & Chemical Review says: "It is generally accepted that they fall into one of three general classes: Glazing agents that fuse to block oxygen from reaching the burning area; intumescent agents which puff up to insulate underlying

Manufacturer and Brand Name		No. of Coats	Total Coverage Sq. Ft. Per Gal.	Washable	Colors Available Plus White	Interior or Exterior Use	Underwriter's Laboratories Ratings for Interior Use on Unprimed Wood		
							Flame Spread	Fuel Contributed	Smoke Density
Albi Mfg. Co. Rockville, Conn. Also make two other grades not listed here (Ready mixed)	Albi 107	2	100	Yes	10 Plus	Both	15-20	25	0-5
	Albi 107A	1	100	Yes	Black	Interior	15	15	5
Baltimore Paint & Chemical Co. Baltimore 30, Md. (Powder & liquid to be mixed)	SAF 303	1	150	Yes, when overcoated	8	Interior	15	15	5
	+SAF 202 topcoat	1	500	With SAF 202	8	Interior	10	15	0
Builders Research & Chem. Co. 4990 East Asbury, Denver 22, Colo. (Ready mixed)	F-X With BP58 primer	2 Plus Primer	100	Not scrubbable	6 Plus Clear	Interior	10	10	40
Cheesman-Elliot Co. 647 Kent Ave., Brooklyn 11, N.Y. (Ready mixed)	Firehold	2	87	Yes	8	Both	40-50	20-35	0
E. I. duPont de Nemours Wilmington 98, Del. (Ready mixed)	Fire-Retartant Paint	3	100	Yes	7	Interior	50-70	25-35	5-45
Flamort Chemical Co. 746 Natoma St., San Francisco 3, Calif. (Powder to mix with water for spray)	Flamort WC	3	110	No	Clear Only	Interior	65-70	50-55	Same as bare wood
Glidden Co. Union Commerce Bldg. Cleveland 14, Ohio	Duo Tex	3	70	Yes	White in stock Special colors on order	Interior	50-60	30-35	25-50
Benj. Moore & Co. Newark 5, N.J. (Ready mixed)	Retardo	2	100	Yes	10	Interior	40	25	20
Morris Paint & Varnish Co. 27th & Douglas, Omaha 2, Nebr. (Ready mixed)	Fyr Kote	2	100	Yes	6	Interior	40	35	30

NOTE: The lower the number, the higher the rating. (These coatings also listed for cellulose wallboard.)

material from an adjacent fire; and chain-ending agents that smother a fire by releasing or by chemically combining to form nonflammable vapors, thereby excluding oxygen." None of these should be confused with incombustible paints which will not ignite, but which do nothing to halt flame-spread or heat penetration in the material underneath. As the Navy learned long ago, coat upon coat of ordinary paints applied to surfaces can add considerable fuel and fumes to a going blaze.

The majority of the protective paints now available are of the intumescent type, and many also generate oxygen-excluding ing vapors. Put a blowtorch flame on a piece of board coated with such a paint and the coating immediately blackens, then puffs out to a thick, insulating pod or blister resembling a scorched marshmallow. This blister will glow until the flame is removed, whereupon it "blacks out." The charred area can then be scraped clean and refinished.

In other words, the coating does not support flame nor add appreciable fuel to the fire. Equally vital, it checks the penetration of the heat so effectively that you can safely put your bare hand on the opposite side of the board while the blowtorch is still operating.

How important this factor is was shown in a test which I saw the Cleveland Fire Department make some ten years ago. A condemned, five-room dwelling was used for the experiment: The basement ceiling was painted with a fire retardant coating; the basement was stacked with old orange crates and packing boxes which were set ablaze and allowed to burn for 25 minutes. In this time the pyrometers showed a temperature of 1600° F. Yet not only were the ceiling beams and floor boards uncharred—but the temperature in the room directly above never exceeded a safe 205°. (It takes 325° to ignite a parlor match; 446° to touch off cotton batting.) Since then this particular paint has been greatly improved for less flamespread and much longer heat resistance.

It is important, of course, that a fire-retardant coating add no toxic fumes to a fire, and all of those listed by the UL are free from this hazard. The amount of smoke contributed also is very significant, since smoke kills far more fire victims than flame. This feature is rated in the UL listings and shows a wider variation than either flamespread or fuel contributed.

Since the function of a fire-retardant coating is to upgrade a free-burning material—or even a flash-burning one, such as cellulose wallboard, to the category of slow burning or fire retardant, a word

Above, after 6 min. exposure to an alcohol fire, flames are beginning to lick through the floor of the untreated plywood house at the right. House at left has been coated with fire-resistant paint

Above, after 12 min., the alcohol fire in both houses has burned out. As you can see, the untreated house at right is ablaze while there is no flame in this length of time in the treated plywood house

Below, after 20 min., the untreated house is completely consumed by flames. Treated house is scorched and has hole in floor where it was in direct contact with the fire but is otherwise intact and unharmed

Only damage done to interior by fire was puffing of fire-retardant paint although furnishings were destroyed. Swelling, spongelike insulating puff is easily scraped off with putty knife and surface repainted

about the standards employed is in order. The inherent rate of flamespread of a given material is measured at UL by inserting a 25-ft. sample in a tunnel; applying flame to one end for three minutes; then checking the time it takes for the flame to travel to the opposite end. With untreated red oak, which is the standard yardstick, this takes five to six minutes. This is considered normal for an average combustible, hence is so rated as 100 in the scale. On this basis, flamespread ratings given in the National Fire Protection Association Handbook classify noncombustible as 0-15; fire retardant, 16-30; slow burning, 31-75; combustible, 76-200; highly combustible, over 200.

The majority of fire-retardant coatings come ready-mixed and in a number of decorator colors, mostly flat. (Some users apply a regular enamel top-coat for a gloss finish.) They are applied just as easily as a typical paint, by either brush or spray. In the early days there was an irritating odor during application, but that stage has long since passed among the better brands. Coverage per coat is roughly about half of that expected from a conventional enamel. If you want greater coverage with proportionately less protection, you can spread it thinner than specified in the UL listings. To be specific on this point, one leading brand has a flamespread rating of 10 for two coats at 200 square ft. per gal. per coat. A single coat of this same paint at the same coverage gets a flamespread rating of 25. This is still very good—but it is like going out in the rain with only one rubber.

Most fire-retardant coatings can be applied over an existing paint surface, but in this case two coats are required for the same rating obtained by one coat on unpainted wood. Some brands also protect any interior surface, including metal. Such paints are widely used to raise the protective rating of gypsum board by from 50 to 90 percent, and they are taking the notorious metal ceiling out of the fireman's nightmares. In one test, for example, an aluminum panel was melted in 2½ minutes by a 2200-deg. welding-torch flame. A similar panel coated with a top-grade fire-retardant paint remained intact after 25 minutes of the same temperature.

Some of these paints have a life expectancy of 10 to 12 years under normal indoor conditions. They also can be washed repeatedly, even scrubbed, which is rather important for home use. However, there are brands, which are acceptable fire retardants, but are water soluble, hence will not tolerate high humidity. This is a point to remember if you're looking for bargains.

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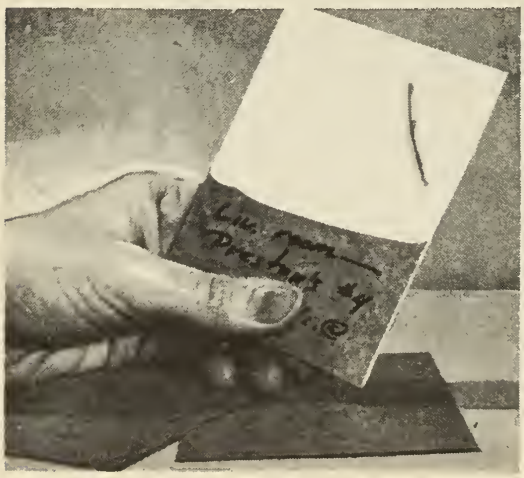


PAINT DATA is recorded on hardboard scrap dipped in paint used on a job. Board is then cut to size for easy filing. When necessary to repaint, or touch-up repaired surface, simply consult paint-data file

Painting Over New Plaster

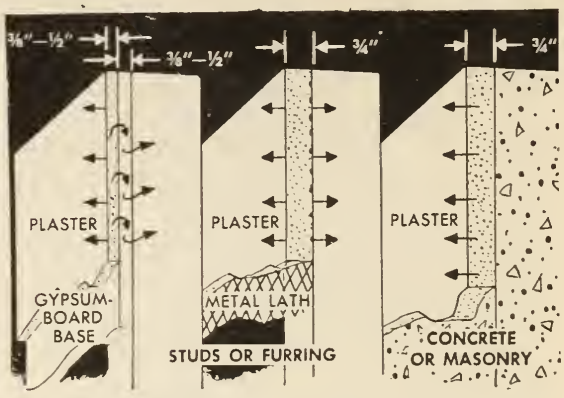
By E. R. Haan

BEFORE you start spreading gay colors on the interior walls of your new home, just make sure that the plaster is actually ready for painting in respect to dryness and surface condition. Then you can be reasonably certain that the paint job will be uniform in appearance and free from blemishes.

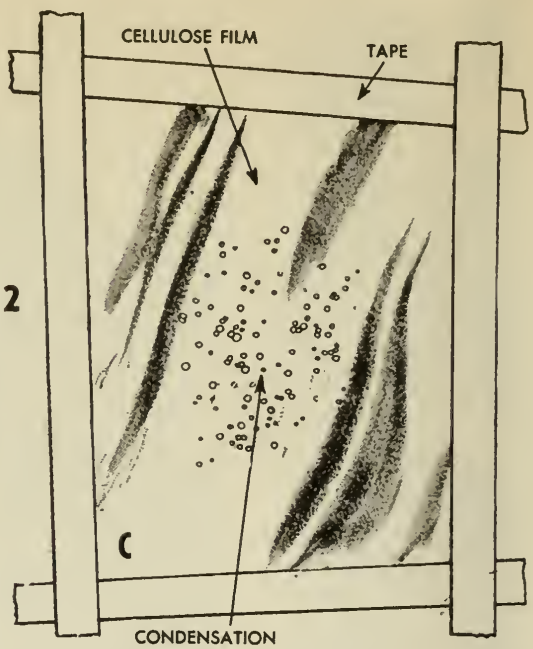
Too much dampness in new plaster may delay the painting or influence the selection of paint. Surface conditions, such as soft spots, chalkiness, efflorescence and the presence of hairline cracks, should be corrected. These conditions also may be influential in the paint selection.

Dryness of Plaster

If you are intending to use alkyd or oil-base paint, dryness of plaster is of utmost importance. For many years painters followed the rule of waiting six months to two years before applying oil-base paint to interior walls. Today, however, improved formulation of both plaster and paint have shortened this waiting period. For average conditions of varying humidity, a 60 to 90-day drying period often is recommended. But when the relative humidity is not over 40 percent, and the temperature is not less than 50 deg. F., plaster on partitions or furred walls often dries sufficiently in three or four weeks. Dry air absorbs large quantities of moisture from plaster quickly, but humid air, which is already loaded with moisture, retards drying time considerably.



The drying rate of plaster varies with the type of wall construction. There is



less water to evaporate from a plaster coating on a gypsum-board base, Fig. 1, than from a thicker three-coat plaster covering on expanded metal lath. Plaster on frame partitions or that applied to a base over furring, dries from both sides. The slowest to dry is plaster applied directly to concrete or masonry.

Tests for Plaster Dryness

To determine accurately how dry plaster is, and whether it can be painted, professional painters often make use of a moisture meter, such as pictured in Fig. 2, detail B. Homeowners, however, can make other simple tests. If a match fails to ignite when struck on plaster, it is an indication that it is still too damp for the application of an alkyd or oil-base primer. Another test consists of taping a small sheet of cellophane or celluloid loosely to the wall, sealing the edges all around with strips of masking tape. If any condensation appears on the inside surface of the sheet in the course of a few days, the plaster is too damp for an alkyd or oil-base primer.

Painting Damp Plaster

When it is necessary to paint damp plaster, a single coat of water-base paint, preferably of the latex variety, usually will adhere but may not give the desired coverage. A single coat will still permit evaporation of moisture in the plaster to continue. Two coats of latex paint should not be applied to a damp wall since the paint film then becomes a moisture barrier, preventing further evaporation from the plaster. Moisture remaining in the plaster builds up pressure under the paint and may cause it to loosen in spots unless sufficient evaporation occurs from the opposite side. Therefore, the second coat of paint is applied after the wall has dried completely. The pigments in some paints react to the alkali which is drawn out of the plaster by the moisture, resulting in spottiness.

Dry-outs and Sweat-outs

Some soft spots in plaster that have white, chalky surfaces are known as "dry outs." These are caused by too-rapid evaporation of water before the plaster has set. This condition can be remedied by spraying the area repeatedly as necessary with a solution of alum, 1 lb., dissolved in water, ½ gal., or equivalent proportions. A hand-operated garden sprayer can be used to apply it as in Fig. 4. The added moisture promotes crystallization.

Other soft spots known as "sweat outs" are damp and somewhat dark in shade as indicated in Fig. 3. These are caused by too-slow drying which allows the water to remain in the plaster after it has set. The condition sometimes can be improved by drying the wall with heat, or by applying lacquer to surface-harden these spots and permit painting. If this does not help, it may be necessary to remove the soft plaster and replace it.

Efflorescence and Chalkiness

Efflorescence, shown in Fig. 5, is a thin deposit of soluble salts from concrete or masonry to which plaster is sometimes applied, and is brought to the plaster surface by moisture. When such deposits are

3 "SWEAT OUT"—DAMP, SOFT SPOT, SOMEWHAT DARK

found, they are brushed off repeatedly over a period of time until they no longer reappear. Brushing is done dry, without any water. If necessary to paint over efflorescence, it should be done with latex paint. Similar white deposits on a plaster surface often result from water leaking through it, originating from a roof or wall leak. This can be stopped only by finding the leak and repairing it permanently.

Plaster that has a dull, nonreflective surface may be covered with a white, chalky film which rubs off easily. This condition is quite common and causes paint to peel. The chalky film is brushed off and then an alkyd or oil-base primer is used. A water-base paint will not adhere to a surface covered with this powder.

Oil Spots and Hairline Cracks

Any apparent grease or oil on plaster should be removed with a cloth saturated with white gasoline or benzine. When dry, the spot is washed with a detergent solution and then allowed to dry before painting. Sometimes hairline cracks develop in the finish coat of plaster and do not show up until the wall is painted. Such cracks can be filled with Spackle, using a putty knife on smooth plaster or a stiff-bristle brush on rough plaster. On smooth plaster, the Spackle is sanded when dry. Hairline cracks often can be obscured with a heavy-bodied paint over the primer.

Painting

The first coat of paint is a primer sealer. This renders the plaster surface uniform so that there will not be varying spots of sheen and dullness. When using an alkyd or oil-base primer, it should be allowed to dry for at least a week before the top coat is applied. If the latter is applied too soon, peeling may result. An oil-base finish paint can be applied over a latex primer, but will not adhere properly to other water-base paints. It is important to mix the paint thoroughly before application and to keep it well stirred to assure good coverage and uniformity of color.

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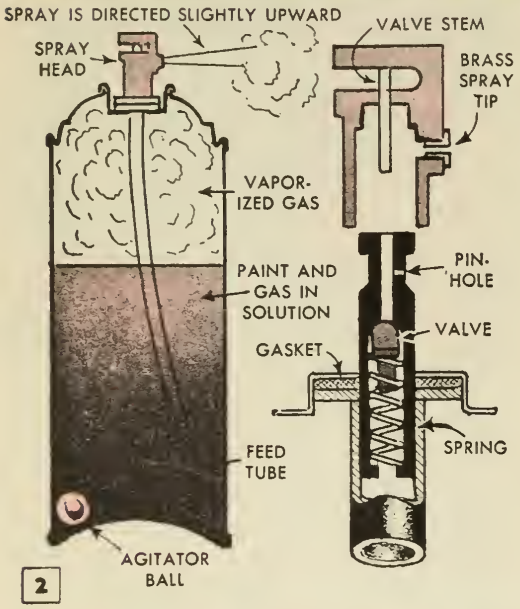
1

PUSH-BUTTON

IF YOU LIKE push-button magic, you'll enjoy doing touch-up and small painting jobs with pressurized spray paint. Lacquer and enamel paints are made in a variety of colors, finishes and brands and sold in handy 12 and 16-oz. cans, Fig. 1. Also available, are clear and opaque plastics, lacquers and varnishes that are ideal for spraying photographs, drawings, flowers, electrical circuits and other objects with a protective film to guard against moisture and dust damage. Any child can paint with the cans, and, with a little practice, you can turn out first-class professional work.

This is how most types of spray cans work: The main body of each can is pressurized with a liquid gas, usually Freon or Genetron. The gas vaporizes and develops a pressure of about 30 lb. per sq. in., forcing the liquid up the feed tube, ready to be released at the touch of your finger. The liquid gas in solution with the paint contributes to atomization by giving the paint particles a kind of explosive action, producing a fine mistlike spray. The gas itself is harmless, vaporizing instantly on exposure to air. Fig. 2 shows a typical valve and spray head, although there are numerous variations. The spray head itself can be removed for cleaning.

The table, Fig. 3, gives data on some of the various products available. The clear acrylic solution contains no pigment and



2

3 TYPE OF PAINT	GENERAL USE	WORK DISTANCE	DRYING TIME	APPLICATION AND REMARKS
CLEAR ACRYLIC	CLEAR PROTECTIVE FILM FOR ALL METALS. ALSO GOOD FOR DRAWINGS, MAPS	10 TO 16 IN.	5 TO 10 MIN.	One coat covers. Have work well-lighted so that you can see the transparent coating. Spray a full wet coat. Work should be 70° F. or warmer to prevent clouding. Wipe polished metal with cleaner before spraying
METALLIC	FOR ANY SURFACE WHERE A GOLD, COPPER, ALUMINUM OR CHROME FINISH IS DESIRED	10 TO 14 IN.	10 MIN. TO 1 HR.	Usually covers in one coat. Paint must be sprayed wet to avoid chalking (rubbing off when dry). Some brands and a few types will chalk slightly even though applied correctly and are suitable only for work that is not to be handled
LACQUER ENAMEL	FOR TOUCH-UP OR COMPLETE FINISH. WIDE VARIETY OF COLORS, BLACK AND WHITE	8 TO 12 IN.	15 MIN.	Dries fast. Low pigment content usually requires two or three coats which can be applied in rapid succession. Most products formulated with nonlifting solvents which are safe over any previous finish including varnish
PAINT ENAMEL	GENERAL PURPOSE PAINT, TOUGH AND DURABLE FOR INSIDE OR OUTSIDE WORK, ALL COLORS	12 TO 18 IN.	1 HR. TO 4 HRS.	Cheapest of the various products. Usually requires two coats, the first coat being a light coat followed by a second, heavier coat in about 10 min. Paint remains tacky a long time and tends to clog spray tip
AVERAGE COST ABOUT $2 PER 16-OZ. CAN (ABOUT ½ PINT LIQUID)				

PAINTING

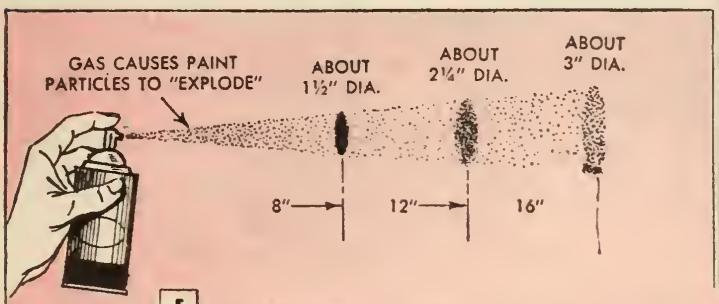
needs no mixing; all others contain a pigment that settles out of solution and requires agitation to mix it properly. The metallics have the most hiding power and will cover most surfaces with one coat. Also, this paint is available in blue, green and red. Metallics should be sprayed wet, since a dry, dusty spray (overspray) of itself causes chalking.

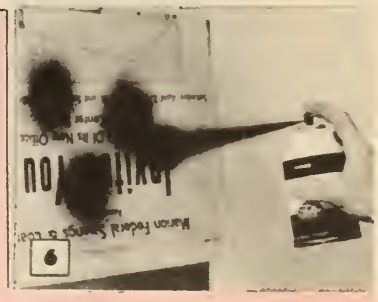
The lacquer products are slightly more expensive than others but have the advantage of fast drying. The least expensive of the various products and also the poorest by virtue of very slow drying, are the paint enamels. However, if you can be patient, the resulting finish is tough and durable. The pigment content of general-purpose paints is very low and will not cover in one coat. The correct procedure for applying these products is to spray a fine coat at 15 to 18 in. from work. Allow 10 min. for this to dry and then apply a second, heavier coat at about 12 in. from the work.

Spray concentration for various working distances is shown in Figs. 5 and 6. The minimum working distance is 8 in., since this space is needed to let the gas escape from the paint which otherwise would erupt, causing pinholes.

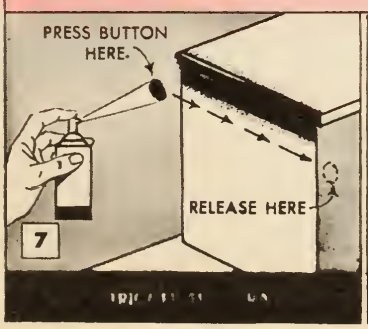
As far as spraying technique is concerned, the main idea is to get the paint on—you'll learn by practice. For most work, the spray should be constantly triggered so that you start and end the spray stroke off the work, Fig. 7. Edges should be sprayed with an oblique stroke, Fig. 10, that covers part of the adjoining surface. You then minimize overspray by starting

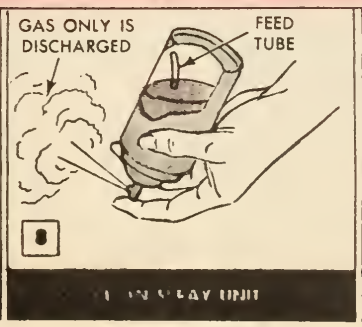
Color bands sprayed on tool handles preserve wood, remind forgetful neighbor to return borrowed tools

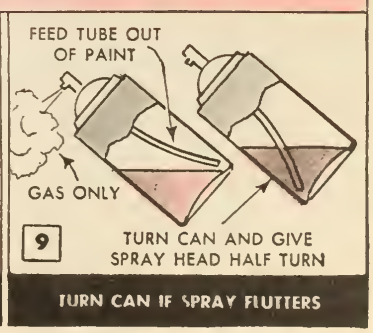




TEST PAINT-SPRAY PATTERN AT VARIOUS DISTANCES FROM WORK







TURN CAN IF SPRAY FLUTTERS

Edges are sprayed with oblique stroke that covers part of adjoining surface to reduce overspray when painting flat surface

Mesh of hardware-cloth support prevents overspray from being deflected onto work

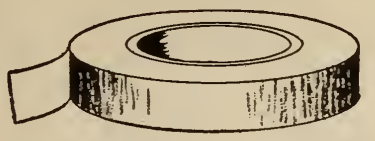
and stopping spray strokes just inside the edges when doing the flat surface. All flat surfaces should be sprayed by starting at the near edge, letting the overspray drift forward on work not yet coated as in Figs. 12 and 13.

Avert Clogging of Tip

After every job, invert the can and depress the button three or four times until you hear the hissing sound of gas only being discharged, Fig. 8. Add to this the simple precaution of wiping the spray tip and you will seldom be bothered with clogging. If the spray tip appears to be clogged, remove the spray head and push a fine wire through the spray hole. If the can has a valve, such as the one shown in Fig. 2, also clean the small hole in the valve body. Spray heads can be switched from can to can, if they are of the same design. A clogged inner valve can be freed by removing the spray head and placing a drop or two of paint thinner in the valve body.

Don't neglect work preparation. The temperature of the paint should be between 60 and 90 deg. F. If it is too cold, the can of paint can be placed in a pan of warm water and heated to the required temperature. The recommended room temperature and atmospheric conditions are the same for this work as apply to other types of painting. If you paint outdoors, use a cover to keep paint off the surrounding area, Fig. 10. An ideal support for small jobs is hardware cloth, Fig. 11, because its open surface allows overspray to escape without settling on the work. When only a part of a surface is to be painted, the adjacent surfaces are masked, Fig. 4. ★ ★ ★

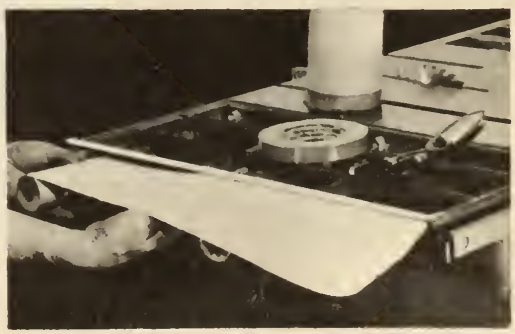
Figs. 12 and 13, flat surfaces are painted by starting at near end, allowing overspray to drift forward on work not yet coated. Fig. 14, cold paint is warmed by placing can in a pan of 90 to 100-deg. water



MASKING TAPE PROTECTS PARTS NOT TO BE PAINTED. USE FLAT-BACKED TAPE FOR STRAIGHT LINES, CREPE BACKED FOR CURVED LINES

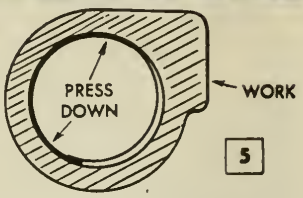
MASKING METHODS IN SPRAY PAINTING

By Sam Brown



Paper shields, or flaps, are made by running tape along a straightedge, such as edge of saw table. Press paper into contact with overhanging edge of tape

A sleeve shield, made from tape or paper masks openings from paint spray. Apply with adhesive side out

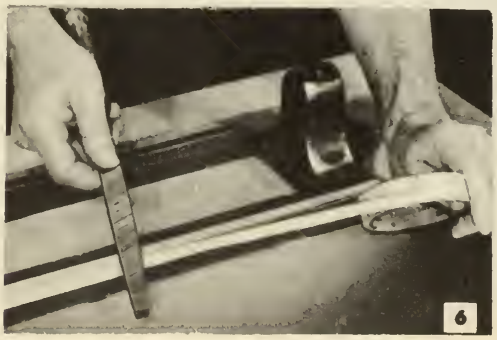


DID YOU EVER look closely at a professional paint job on a workshop machine or project and wonder how it was done? Just how did the painter get those sharp, clean edges, clean nameplates and bolt heads, true stenciling and that uniform paint coat on both the flat and irregular surfaces? As a rule the answer is, he did the job by careful placement of masking tape on those parts which were to be left unpainted, also by using special metal shields he made himself to suit his purpose, and by using rolled-paper or tape shields to keep paint out of holes and other openings. These simple tricks are what give the finished job that certain professional look.

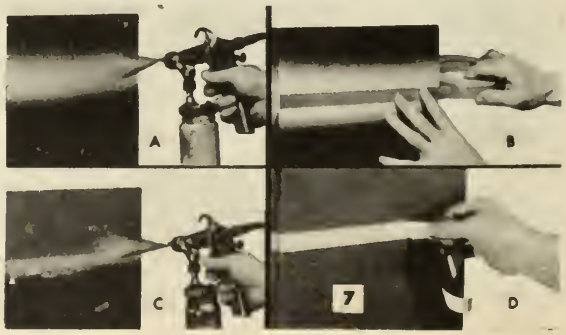
Although masking is practical for use in brush application of paints and enamels, cleaner work will result from spray-gun application. Two kinds of masking tape are used by professional painters, the flat-backed tape and the crepe-backed. The former is useful only for masking along straight lines or edges. It cannot be made to take a curve without looping and possibly leaving some small areas exposed to the paint spray. Where it is necessary to work the tape around a short radius as in masking a nameplate, Fig. 3, always use the crepe-backed tape. Painters usually apply the tape direct from the roll, pressing it down lightly in the desired location so that it can be lifted and reused. Tape also is available with a paper flap attached along the length to increase the total masking width. However, you can easily make your own tape with a paper flap as in Fig. 2, by first applying the tape to any straight edge, the edge of the saw table in this instance, allowing about ½ in. of the adhesive side to overhang. Then press the paper into contact along the overhang.

Another trick to make use of when repainting workshop machines is inserting a tape or paper sleeve in openings to keep paint out. Fig. 4 is an example of its use. The tape is rolled loosely into a sleeve with the adhesive side out and worked into the opening. Then it is pressed into contact with a pencil or dowel as pictured. It's important to be sure the length of tape you cut is long enough to overlap, Fig. 5, when it is pressed into contact. Smaller holes can be shielded simply by rolling a small

Trim tape flush with a corner by using a razor blade or better still, a file. A handy trick to know when you're painting a casting up to a machined surface



Ordinary striping is done in four steps. Spray stripe color A, apply tape of desired width, spray ground color, allow the paint to set and strip off tape, D



sheet of paper tightly, inserting it in the hole and allowing it to spring out against the sides.

It is difficult to lay masking tape flush along a straightedge. The trick here is to apply the tape with one edge slightly overhanging, then trim off flush with a razor blade or a file as in Fig. 6. Nuts and the heads of capscrews simply are wrapped with a short length of tape, care being taken to see that the tape covers the flat faces of the nut or capscrew head all the way down to the surface of the machine part.

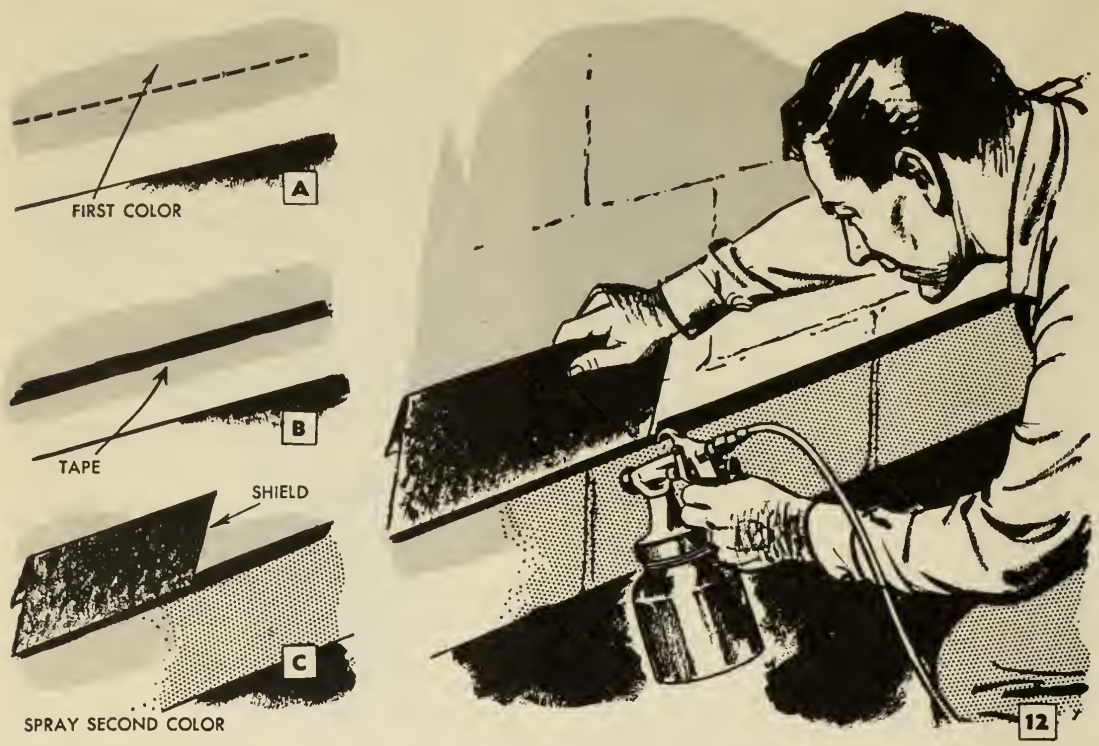
Striping is done in four steps, Fig. 7. After the over-all coat is dry, spray on the stripe color, A in Fig. 7. Allow this to dry thoroughly, then apply the tape, B. Spray over the tape with the over-all color, C. After this coat has set, but before it is thoroughly dry, strip off the tape, D. It's important to strip the tape immediately after the paint has set. If you wait until it is dry, the paint may chip at the edges when the tape is stripped. Strip the tape by pulling it away at right angles to the surface.

Painting, enameling or lacquering a project you've made in your own shop in one color usually is a simple procedure with either a spray gun or brush. Just remove the hardware after fitting, and any other parts you don't want painted, and you're ready to go. Sometimes it's an advantage to remove parts from projects and machines and paint them individually.

While you can use a sheet-metal shield when painting walls up to woodwork, the use of tape, Fig. 8, will assure a better job. If the tape is applied and stripped off carefully, it can be reused a number of times. A metal shield comes in handy to catch over-spray when painting a pipe, Fig. 1.

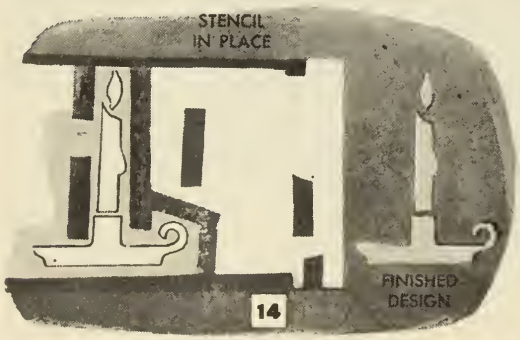
Enameling through a stencil on a shop project such as a copper plate, Fig. 9, can be done with a readycut stencil, or you can cut the stencil yourself. Usually you rubber-cement the stencil stock to the work

Use tape around window and door trim when painting a wall. Makes sharp line where two colors meet



Two colors meeting in a clean, straight line make a neat job on plaster or masonry walls. Use both a tape and shield and proceed as in the three steps, A, B and C. Strip tape immediately after second coat has set

Above, cut small rectangular holes through paper stencil and press tape over openings to hold stencil in place while spraying. Note position of tape below

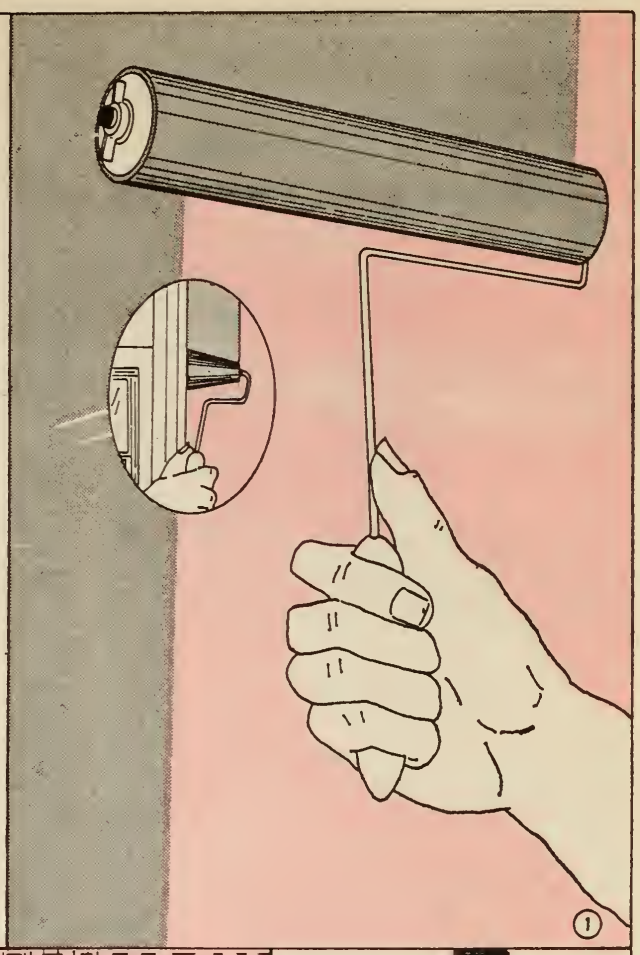


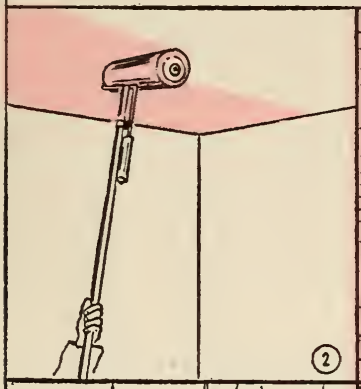
and then cut out the areas you want the paint to cover. A somewhat better way, especially on metal, is to cover the area to be stenciled with strips of tape, Fig. 9, and then cement the design over the tape as in Fig. 10. Or use tape with adhesive on both sides. If the stencil design is to be in two colors, save the pieces cut out so that these can be used to mask out the first color, Fig. 11. Another good way of holding a paper stencil in place while spraying is pictured in Figs. 13 and 14. Cut small openings in the stencil at points outside the design, also in the flap when the latter is used around the borders of the stencil, and then press short lengths of tape over the openings, Fig. 13.

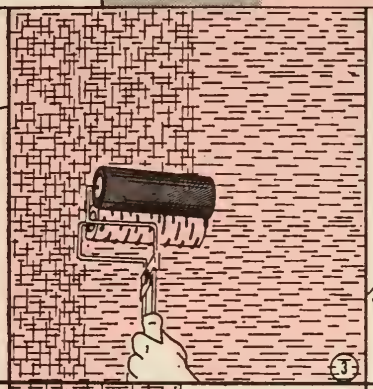
When spraying or brushing paint on plaster or masonry walls and you want two colors to meet in a sharp, true line, use both tape and shield to do the job, Fig. 12. Spray the first color down to a point below the dividing line, A in Fig. 12. Then run the tape along the line, B in Fig. 12, making sure that it is perfectly straight and is pressed into contact all along both edges. Finally, spray the second color, using a shield as in detail C to prevent over-spray from striking the first color above the tape. Strip the tape immediately after the paint sets. If you wait longer the paint may chip along the edges of the tape, resulting in a broken line where the colors meet. ★★★

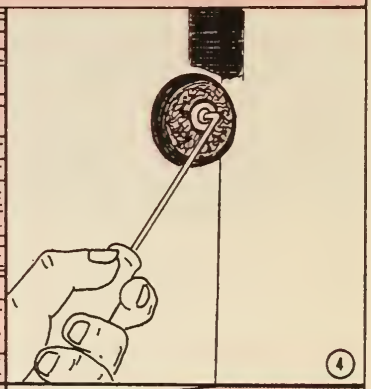
PAINT ROLLERS

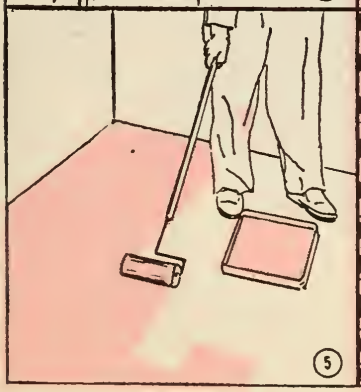
1. Roll up and down, then roll across to blend vertical strokes. Use a trim or edging roller (See detail) in corners and next to trim.
2. Adding an extension to the roller handle will enable you to paint ceilings without using a ladder.
3. Design rollers are available in a number of different patterns.
4. "Doughnut" rollers are designed for working in corners and other tight spots
5. Concrete floors can be quickly and easily painted with a long-handled roller.
6. Hand stamps are available in the same patterns used on design rollers. These can be used in corners and other spots impossible to roll.
7. When painting dropped siding use a "doughnut" roller at joining edges, then finish with a standard roller.

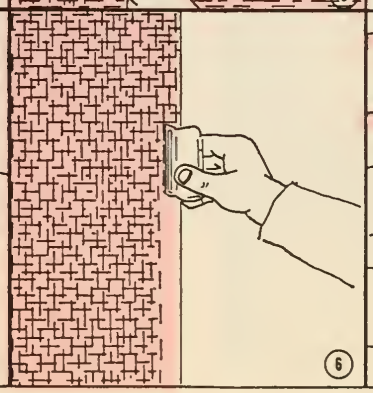


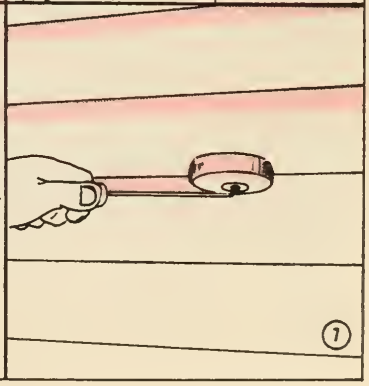


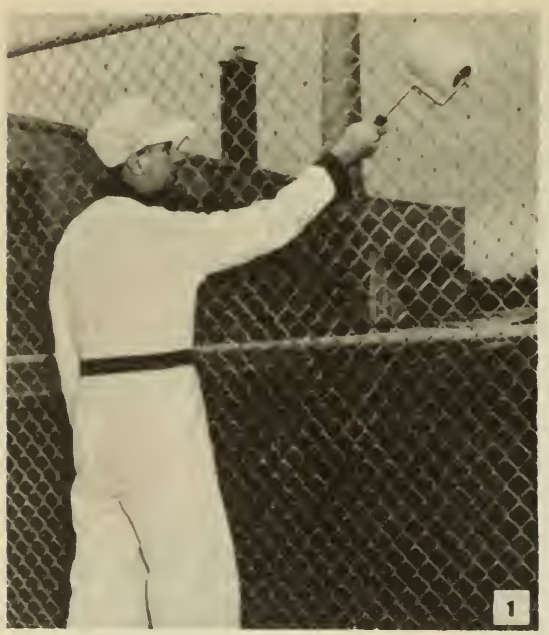




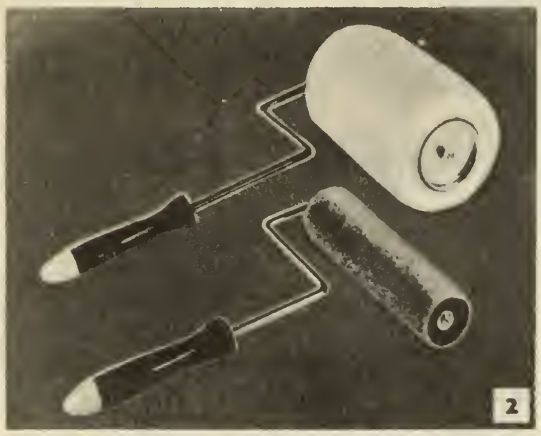




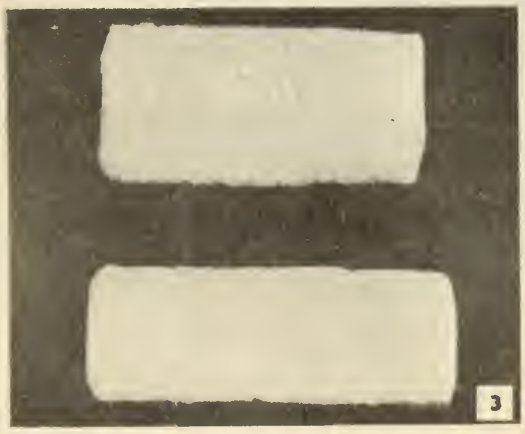




Although it cannot be used for applying rubber or water-base paints, lamb's wool does an excellent job of applying oil-base paints on irregular surfaces such as woven-wire fencing, as shown above



Mohair, above, is ideal for applying enamels. Its short nap holds less paint, flows enamels better. Long-nap lonel, below, is excellent for use on masonry. Pronel is used on fairly smooth surfaces



USE THE RIGHT PAINT ROLLER

IF YOU WANT to do a good paint job with a roller, don't use just any cover on the roller. Modern paints require covers especially designed for their applications, as do the various painted surfaces. For example, wool, which was the first practical material used for the covers of paint rollers, absorbs moisture from water-base paints and causes the fibers to lose their resiliency and paint-holding qualities. To overcome these problems, the EZ Paintr Corporation, in conjunction with fabric and chemical companies, developed synthetic fabrics which do not have the disadvantages of the natural fibers.

Long-nap lonel, Fig. 3, is a densely woven synthetic material that is used for applying paint to masonry and other rough surfaces. Its long fibers are abrasion-resistant and force paint into the many irregularities of this type surface. Applying most types of paint to smooth or semismooth surfaces is done well by pronel, Fig. 3. Its fibers do not break or "finger" and cause an undesired mottled effect.

Lamb's wool, Fig. 2, still has definite advantages for some types of applications with oil-base paints. As an example, painting woven-wire fences, Fig. 1, is done quickly and efficiently with wool.

Mohair, Fig. 2, is a short-nap fabric that is excellent for applying enamels and rubber-base paints to smooth surfaces. Because its short fibers hold less paint than other types, it flows enamels better and reduces "orange peel" to a minimum.

5

6

Special roller, above, is attached to regular roller to make "printed" pattern on painted surfaces. Below, paint from regular roller then is rolled against printing roller which transfers it to painted surface

Short-nap lonel, Fig. 4, is comparable to pronel in the quality of the finish it produces. Dacron, shown in Fig. 4, is used for application of exterior paints on wood siding. Carpet, Fig. 4, is used for obtaining a stipple effect with oil-base paints. A stippling effect also is obtained with frieze, Fig. 5, which is used to apply texture paints on dry-wall construction to produce a semirough plaster appearance.

Figs. 6 and 7 show a specialized roller used for "printing" a pattern on a painted surface. The roller attachment is clamped to the handle of a regular roller, which, when dipped in paint, rolls paint onto the printing roller. A hand stamp is used to finish the pattern in areas not reached by the roller. ★ ★ ★

7

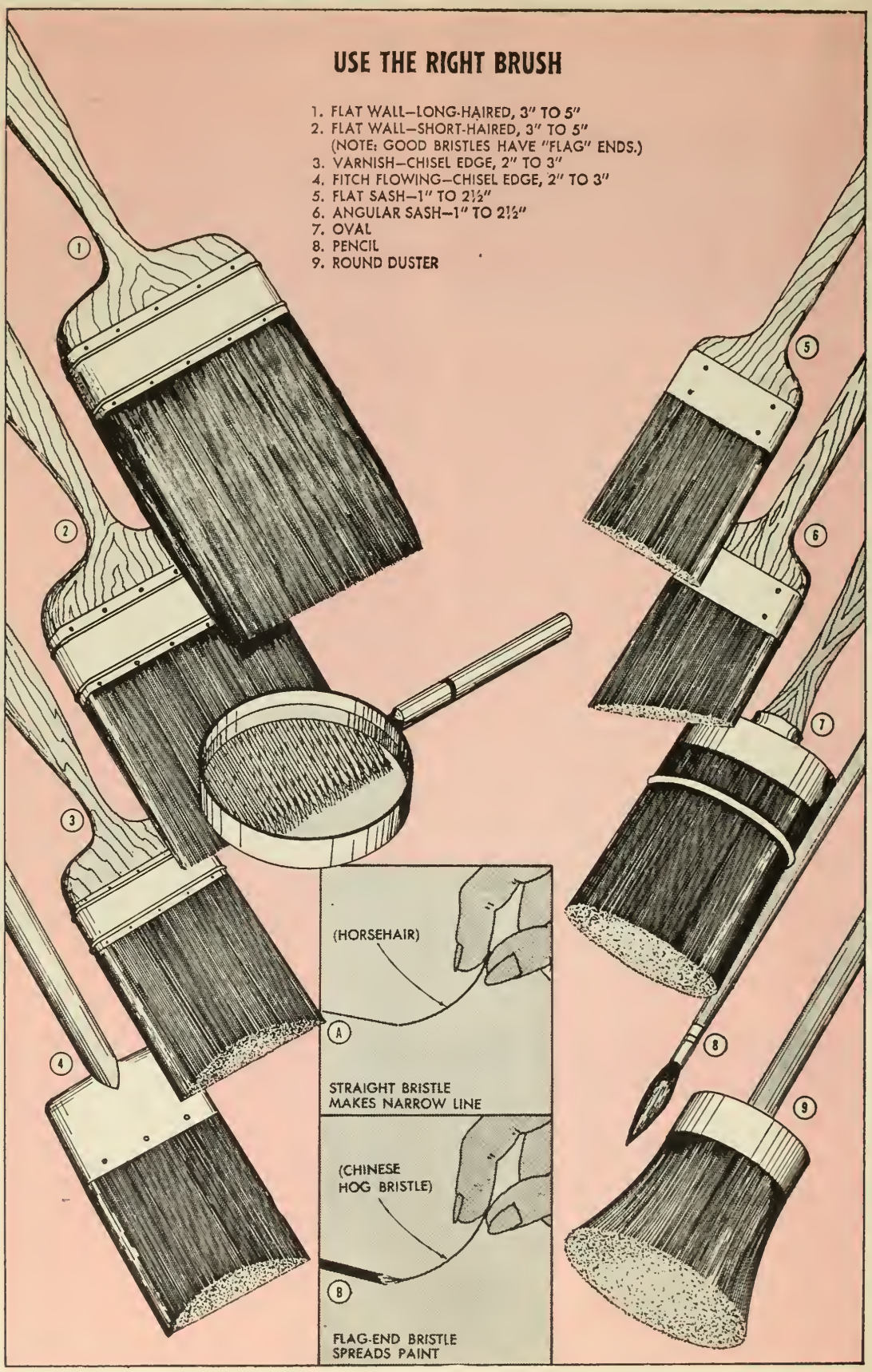
PAINT-ROLLER GUIDE

INTERIOR FINISHING (Covers are listed in order of preference)

	Alkyd Resin Flat	Latex Rubber-Base Flat	Interior Wall Primer	Flat Oil Base	Enamel, Gloss and Semigloss	Enamel, Flat or Satin Finish	Rubber-Base Texture Paints	Water-Base and Emulsion-Type Paints	Shellac or Stain	All Aluminum Paints
Sand Finish Plaster and Dry Wall	Pronel Lonel Mohair	Pronel Lonel Mohair	Pronel Lonel Mohair	Pronel Lonel Mohair	Mohair Pronel Lonel	Pronel Lonel Mohair	Frieze Carpet	Pronel Lonel		
Putty Coat or Smooth Plaster	Pronel Lonel Mohair	Mohair Pronel Lonel	Pronel Lonel Mohair	Pronel Lonel Mohair	Mohair Pronel Lonel	Mohair Pronel Lonel	Frieze Carpet	Mohair Pronel Lonel		
Light Spanish Plaster	Pronel Lonel	Pronel Lonel	Pronel Lonel	Pronel Lonel	Pronel Lonel	Pronel Lonel		Pronel Lonel		
Heavy Spanish Plaster	Long nap Lonel	Long nap Lonel	Long nap Lonel	Long nap Lonel	Long nap Lonel	Long nap Lonel		Long nap Lonel		
Acoustical Surfaces								Pronel Lonel		
Woodwork	Mohair Pronel Lonel			Mohair Pronel Lonel	Mohair Pronel Lonel	Mohair Pronel Lonel			Mohair Dacron	Pronel Lonel Dacron
Stippling Surfaces	Carpet Frieze			Carpet Frieze			Frieze Carpet	Sponge Frieze		

EXTERIOR FINISHING (Covers are listed in order of preference)

	Banding, Cement Points	Exterior Latex Base	Exterior PVA (Polyvinyl Acetate)	House paints (Over Primer)	Exterior Trim Enamels (Over Primer)	Waterproofing, Clears	Exterior Varnishes	Stain	Aluminum Paints
Light Stucco Smooth Concrete	Pronel Lonel	Pronel Lonel	Pronel Lonel	Pronel Lonel	Pronel Lonel	Pronel Lonel			
Heavy Stucco Rough Masonry	Long nap Lonel	Long nap Lonel	Long nap Lonel	Long nap Lonel	Long nap Lonel	Long nap Lonel			
Brick	Long nap Lonel	Long nap Lonel	Long nap Lonel	Long nap Lonel	Long nap Lonel	Long nap Lonel			
Wood Siding				Dacron Pronel	Dacron Pronel		Mohair Dacron	Mohair Dacron	Pronel Dacron
Asbestos Siding		Pronel Lonel	Pronel Lonel	Dacron	Dacron Pronel				


USE THE RIGHT BRUSH
1. FLAT WALL—LONG-HAIRED, 3" TO 5"
2. FLAT WALL—SHORT-HAIRED, 3" TO 5"
(NOTE: GOOD BRISTLES HAVE "FLAG" ENDS.)
3. VARNISH—CHISEL EDGE, 2" TO 3"
4. FITCH FLOWING—CHISEL EDGE, 2" TO 3"
5. FLAT SASH—1" TO 2½"
6. ANGULAR SASH—1" TO 2½"
7. OVAL
8. PENCIL
9. ROUND DUSTER
(HORSEHAIR)
A
STRAIGHT BRISTLE
MAKES NARROW LINE
(CHINESE
HOG BRISTLE)
B
FLAG-END BRISTLE
SPREADS PAINT

Paint-Mixing Guide for Matching and Touching Up

A KNOWLEDGE of paint-color mixing is useful for the home craftsman who often has to touch up a nicked wall or match an article of furniture. If a few simple rules are followed, there is nothing difficult about color mixing. The most important thing to remember is to add the color to the white paint in small amounts, bringing it slowly up to the desired shade. The paint should be stirred thoroughly as the color is added to break up the pigment and mix it completely, thus avoiding streaks. To get an immediate idea of how the color you have mixed will look when it is dry, apply a small amount to a blotter. All colors used in the following formulae are colors in oil, which can be obtained from most paint stores in quantities as small as ¼ oz.

Color Formulae

The colors in oil specified in each of the formulae below are added to white in the proportions shown

APRICOT: Add a little bulletin red, lemon yellow

BLUE, delft: Cobalt blue, a touch of lampblack

BLUE, pale: Add a small amount of Prussian blue. To deepen, add more Prussian blue

BROWN: Use burnt umber alone. Add white to lighten or Venetian red for a reddish brown

BUFF: Quite a little raw sienna. For a rich buff use a little French ocher and burnt sienna

CORAL: Chrome yellow, medium, and vermillion

CREAM: Raw sienna. Darken with more raw sienna

ECRU: Add yellow ocher and a little burnt umber

FAWN: Burnt umber, 3 parts, yellow ocher, 2 parts

GREEN, apple: Add light chrome green and a little chrome orange to the white

GREEN, blue: Prussian blue and chrome green

GREEN, jade: Considerable chrome green and a little Prussian blue and Venetian red

GREEN, olive: Chrome yellow and lampblack

GREEN, sea yellow: Chrome green medium, raw sienna and a trace of chrome yellow

GREEN, soft: Chrome yellow, chrome green and raw sienna

GOLD: Chrome yellow and a little Venetian red

GRAY: Add lampblack to white. Add a little Prussian blue for French gray

GRAY, stone: Raw sienna and raw umber. For silver gray, add lampblack

IVORY: A little raw sienna and a trace of vermillion

LAVENDER: Ultramarine blue, 3 parts, madder lake, 1 part

LILAC: A little ultramarine blue and rose madder

MAIZE: Chrome yellow, medium, and lemon yellow

MAROON: Venetian red, a trace of lampblack and a trace of Prussian blue

ORANGE: Chrome yellow, medium, and a little vermillion

ORCHID: Rose pink added to white

PEACH: Chrome yellow and a little vermillion

PINK: Vermillion added to white

RED, brick: Vermillion, 2 parts, Indian red, 1 part

ROSE: Small amount of Tuscan red, vermillion

ROSE, old: A small amount of crimson madder

SALMON: Quite a bit of orange chrome, deep

SAND: Yellow ocher and a trace of lampblack and vermillion

TAN: Add burnt umber to white

TOPAZ: Chrome yellow, medium, a little vermillion

WISTERIA: Cobalt blue, 2 parts, crimson, 1 part, and a trace of ivory drop black

YELLOW: Chrome yellow added to white

YELLOW, colonial: French ocher, 2 parts, chrome yellow, medium, 1 part

After brush has been spun dry, bristles are combed out as above, to remove kinks. Below, wrap the brush in heavy paper and lay it flat for long storage

Enlarged view of bristles, below, shows "flags" on good brushes. Flags are visible when brush is held up against light. Brush without flags leaves marks

PAINTBRUSHES

Will do a better job and last longer if you know how to select, use and care for them

By Bernard Gladstone

IN PAINTING, as in other types of work, the quality of the finished job depends to a large extent on whether or not you use the proper tools. Economy when purchasing a paintbrush is no substitute for quality, as an inferior brush cannot possibly turn out a good job. And a top-quality brush, when properly handled, will produce a smooth, streakless finish and will outwear several of the cheaper variety.

The best paintbrushes are made of 100 percent pure Chinese hog bristles which have been carefully selected and blended. There are also nylon brushes of excellent quality on the market, which wear well on rough surfaces such as raw lumber. However, they should never be used with shellac, as the alcohol in the shellac will soften the bristles. The bristles can be restored by immersing for 30 min. in boiling water and then drying thoroughly.

To compare brush values, run a pencil through the bristles at the heel of the brush next to the ferrule. Carefully separate the bristles to expose the setting, which is a block set into the ferrule to separate the bristles and to provide a well for the paint. In a good brush this is no wider than absolutely necessary, and is often split into 2 or 3 dividers. This will provide the user with a fully stocked brush and cause the bristles to lie together at the tip to form a good cutting edge. If the block is too thick, the edge of the brush will split lengthwise.

Grasp the brush as for painting and press down with moderate pressure on a flat surface. A good brush will form a sharp chisel edge. Now hold the brush up to the light and examine the bristle tips. Little split ends or "flags" can be seen on a good brush. Without these "flags," a brush will leave streaks in the finished job. A fine brush has flagged bristles in staggered lengths, so that a new set of bristle ends is presented as the longer ones are worn down.

You want not only a good quality brush but also the right brush for the job. The most common types are shown in the accompanying illustration to help in determining your needs.

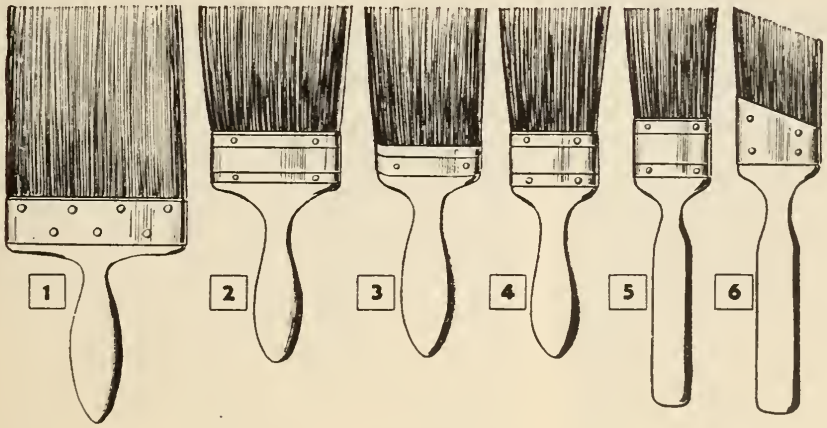
Having purchased a new brush, it's important to break it in properly. Unwrap

the brush and, holding firmly in one hand, slap the bristles vigorously across the other hand. Then hold it up to the light and remove any loose bristles you see. Spin the handle rapidly between the palms and again remove any loose bristles. Then comb the bristles straight to remove any curl. Now wrap the bristles in heavy paper and suspend the brush in linseed oil for at least 24 hrs. The oil should overflow the top of the wrapper and saturate the bristles. Nylon brushes do not need to be soaked, but this is very important with hog bristles, as they are porous. Soaking in linseed oil seals up the bristles, helping to keep them flexible, and makes the brush easier to clean. Remove most of the oil by dragging the flat side of the brush against a wire fastened across the top of the can. Take out the remaining oil by twirling the handle between the palms, with the brush held well down into an empty can. Then wash in two rinses of clear turpentine and spin dry again. Finally, comb out any kinks.

To use a paintbrush properly, dip about ⅓ to ½ the length of the bristles into the paint. Dip it slowly to allow time to soak up the maximum amount of paint. When removing the excess paint, draw the brush flat across a wire fastened across the top of the can. Never draw it edgewise, as this

Above, two methods of suspending brushes in solvent. Brushes should not be allowed to rest on bottom of can, as resulting curled bristles cannot be straightened

After soaking new brush in linseed oil for 24 hrs., it is spun dry by rolling rapidly between palms. Brush is held well down in empty pail for spinning



1—Flat wall, long haired, 3-5 in.

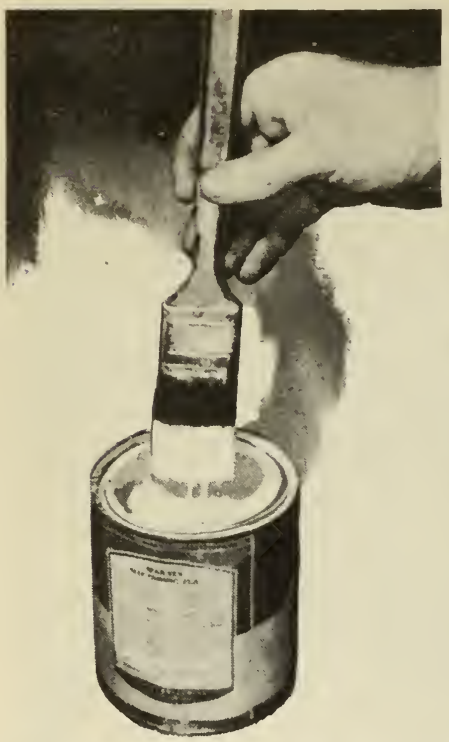
2—Flat wall, short haired, 3-5 in.

3—Oval varnish, 2-3 in.

4—Flat varnish, 2-3 in.

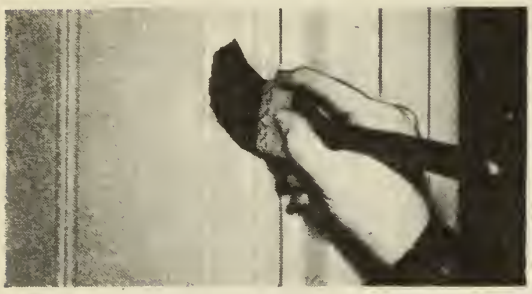
5—Flat sash, 1-2½ in.

6—Angular sash, 1-2½ in.



Above, a wire stretched across the paint bucket offers a double advantage. Excess paint is removed by drawing brush across it, and when brush is not in use wire acts as a rest

Proper procedure of dipping brush is shown at the left. One-third to ½ of bristle length is dipped slowly, so that brush can absorb maximum amount of paint. Paint with end of bristles



Never paint with the edge of a brush, as this will cause "fingering." For sash and other narrow places, use a sash brush, which is made to be used edgewise

The photo above shows a badly "fingered" brush which has been used edgewise so often that its normal brushing characteristics have been ruined

When washing out a brush after painting, work it vigorously against the sides and bottom of the solvent container. Change the solvent several times

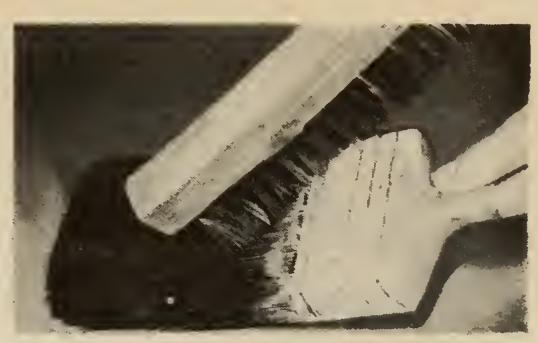
Use the thumb and forefinger to help remove all of paint. Squeeze from the ferrule down toward the tip of the bristles, dipping in the solvent each time

will cause it to "finger" or separate into clumps. Professional painters often prefer to tap the tip of the flat side of the brush lightly against the inside of the can, which leaves the brush more fully loaded.

Brushing varnish, enamel and lacquer calls for a fully loaded brush and a minimum of brush strokes. Brush out the paint in smooth, parallel strokes, and then cross it once to smooth out any brush marks. On vertical work, finish up with long light strokes running the length of the work. Keep checking back for 15 or 20 min. to catch any runs. Hold the brush at a 45-deg. angle and brush with ⅓ to ½ of the bristle length. Don't press down hard, as you will then be painting with the sides of the bristles instead of the ends, causing a streaky job. Never use a brush edgewise, because it will "finger," ruining its good brushing characteristics. If you have narrow surfaces to cut in, use a sash brush, which is made to be used edgewise. If occasionally you have to use the edge of the brush always finish up with a few flat strokes to remove the fingering.

When painting up into a corner, never poke the brush into it. Start the brush a little way from the joint, apply moderate pressure to fan out the bristle, and gradually work the cutting edge into the corner.

If brush cleaning is done immediately after use, it is a comparatively simple task. First wipe off as much of the excess paint as possible and then wash thoroughly in the appropriate solvent by working the brush vigorously against the container sides and bottom. Squeeze the bristle out with the thumb and forefinger, working from the ferrule to the tip. Repeat the process several times, using fresh solvent each time. Then spin the brush dry, between the palms and comb out. If the brush is to be used again in a day or so, wrap in heavy paper, saturate in linseed oil and lay it flat. If the brush is being stored for a longer time, after using the solvent wash thoroughly in warm water and neutral soap. Clean carefully around the ferrule and heel of the brush. Separate the bristles to expose the block and scrape the plug clean of any paint. A wedge of hardened paint will cause the brush to bulge at the ferrule and flare at the tip, making it difficult to spread paint evenly. When the brush is clean, rinse in running water, spin dry and comb out. Then allow it to dry thoroughly. Never dip a paintbrush that is damp into oil or paint, as this will cause the bristles to lose their spring. After the brush is dry, wrap in heavy paper, soak in linseed oil and lay flat in a cool, dry place. If the brush is stored for a lengthy period, unwrap it occasionally and resaturate with linseed oil. ★ ★ ★



A wire brush can be used to scrape dried paint from the handle, around the ferrule and from the heel. In stubborn cases, wire brush is used on bristles

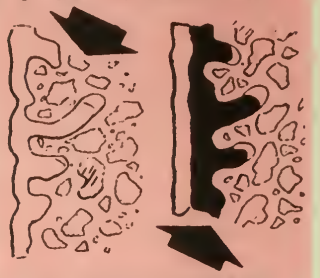
Before storing a paintbrush for a long period, separate bristles as shown above and clean paint from the well with a screwdriver or narrow putty knife

Sometimes a badly-caked brush can be salvaged but it will never be as good as a brush which has been well cared for, and reclaiming it is a lot of work

Cement Paint

IS LEAST EXPENSIVE WALL FINISH BUT TAKES MORE TIME TO APPLY AND CAN ONLY BE USED FOR WORK NEVER BEFORE PAINTED. NOT SUITED FOR FLOORS. APPLY WITH A BRISTLE WALL BRUSH AND WORK IT INTO PORES OF CEMENT WITH A SCRUB BRUSH IF NECESSARY. PATCH CRACKS WITH STIFF PASTE MADE FROM THE MASONRY PAINT ITSELF

GOOD ANCHOR IS OBTAINED ON BARE CONCRETE SURFACE



POOR ANCHOR IS OBTAINED ON SURFACE PAINTED BEFORE

CONCRETE

WATER-MIX TO STIFF PASTE

MORE WATER AND HAND MIXING

PERFECTLY DRY concrete can be painted with almost anything. However, concrete invariably must contend with moisture—and that's a far different story. The moisture itself is bad enough, but teamed with concrete it continually releases lime which is destructive to ordinary oil paints. All good concrete paints resist this combined water and chemical action.

Cement paint: Cement paint is 85 percent cement and the rest is mostly pigment. You can buy it for 10 cents a pound and you can also pay 40 cents a pound, the difference being in the grinding. A fine-ground cement will brush and cover better than a coarse mix. However, the cheap, coarse mix is just as good where big voids must be filled. Cement paint has none of the resins or oils which make other paints stick—it depends mostly on mechanical anchorage for bonding. Hence, it is not

STRAIN THROUGH SCREENING

SLUSH CRACKS WITH PAINT

FILL CRACKS WITH PASTE

PAINTING

recommended over a surface previously painted. Even on cement paint itself, no later application is as good as the first. Because the coating is simply a thin layer of cement, this paint is much too brittle for floors.

Patching cracks: Cement paint is excellent for patching under any finish. Start by mixing a stiff paste of the cement powder, Fig. 1. Put some of this in a tumbler and thin to milk consistency. Slush this mix into cracks for a bonding coat, Fig. 4. Follow immediately with the stiff paste, Fig. 5. For cracks over ¼ in. wide, mix sand, 2 parts, with cement paint or cement, 1 part. Let the patch flat out until it does not look wet, then spray or brush with water, Fig. 6. Keep the patch wet for a couple hours; when the wet surface does not rub off, Fig. 8, the paint is cured. If you are not using a cement-paint top coat, patching can be done with other types of patching materials, including calking compound.

Rubber Base

IS IDEAL FINISH FOR ALL CONCRETE JOBS . . INSIDE OR OUT . . . WALLS OR FLOORS. EASY TO APPLY BY BRUSH OR SPRAY. ONLY DRAWBACK IS THAT IT COSTS A BIT MORE THAN OTHER SUCH PAINTS

ROOF BRUSH IS HANDY FOR OUTDOOR PAINT APPLICATION

CURE PATCHES WITH WATER

KEEP THE PAINT WET

GIVE CURE THE RUB TEST

Old Paint
IS MESSY TO REMOVE BUT IF IT IS POWDERY OR SCALY IT'S BEST TO GET RID OF IT. PARTIAL REMOVAL IS USUALLY SUFFICIENT. USE A FIBER SCRUB BRUSH FOR AN EASY JOB

REMOVE WHITEWASH AND CALCIMINE WITH HOT WATER. USE 20-PERCENT SOLUTION MURIATIC ACID FOR WATER-RESIN PAINT

A CAN OF LYE (13 OZ.) WITH 1 GAL. HOT WATER WILL REMOVE OIL PAINT. WEAR RUBBER GLOVES. RINSE JOB WELL

Mixing cement paint: Like other hard-to-mix materials, you start by making a stiff paste, Fig. 1, adding water gradually. The best way to get out the lumps is to dig in with your hands, Fig. 2. However, cement paint is not kind to some hands, so it is best to wear rubber gloves when doing this. As an alternate or further step in getting a smooth mix, the paint can be strained through screening wire, as shown in Fig. 3.

Application: The wall must be damp to start; then, after the paint has obtained its initial set, it must be cured by further wetting. After making patches where needed, allow 24 hrs. to dry Then, spray the entire surface with water. Let the water soak in. Spray it again until uniformly wet. Let the wall dry out so that it is not actually wet on the surface, and then start painting. This paint settles fast and should be worked from a shallow pan, dipping the brush to the bottom. On a very porous surface, application should be made with a bristle wall brush, scrubbed in immediately and thoroughly with a scrub brush, and then tipped off with the bristle brush. On an average, slightly porous surface, the scrubbing can be eliminated. On cinder block, mix equal parts of clean sand and paint powder for the first coat.

Curing cement paint: Cement paint will reach its initial set an hour or two after application—it will then lose its surface wetness and appear flat. At this stage, it should be wetted with a spray gun or fine spray from a garden hose. About two hours are needed to complete curing, and this may require just one wet or 10 wets, depending on the weather and job location. When the wet coat resists rubbing, it is cured. Allow 24 hrs. dry before recoating. Wet down before the second coating, and cure the second coat just like the first. Good curing is important, but don't rush it; paint wetted too soon is liable to scale. The other side of the situation is that if you neglect curing, the paint will be powdery when dry.

What about old paint?: Most manufacturers do not recommend cement paint over a surface previously painted. However, for a basement wall where there is no weathering problem, it is safe enough to use cement paint providing the old finish is thoroughly removed. With other paints, removal of an old coating is not so important. So long as the old paint is sound, any of the other paints will stick. Hence, wall preparation can be confined to a simple dry brushing. If whitewash or calcimine, it is usually worth while to remove the old coat at least partially. This is easily done with hot water, Fig. 10. Muriatic acid, 1 part, to water, 4 or 5 parts, is a good final cleaner for water paints and will also etch the wall, making a good base for the new paint. Oil paint is the tough stuff. Dry brushing with a power wire brush will knock it off, but you'll be eating dust for a week. One pound of lye with 1 gal. of hot water is a stock oil-paint remover, although much of its magic is pure elbow grease. Neither acid nor lye will touch old rubber-base paint, so

Rubber-Base Masonry Paint

DRIES FLAT AND IS INTENDED FOR WALL USE, NOT FOR FLOORS. CAN BE USED INSIDE OR OUT, ON BARE CONCRETE OR OVER OLD PAINT. GOOD FOR ASBESTOS SHINGLES. THE BRUSHES MUST BE CLEANED WITH SPECIAL THINNER PROVIDED

all you do is smooth down any bad spots with sandpaper. If you do any cleaning up with water, remember it takes a couple of days to dry.

Rubber-base wall paint: The best application is by brush since rubber-base masonry paint is too heavy to spray with average homeshop equipment. However, it can be sprayed if thinned with about 1 pt. of the special thinner to 1 gal. of paint. A nice feature about spraying rubber base is that it does not dust nearly as much as other paints; a poor feature is that it tends to clog the nozzle of the gun when used too thick. A second coat of rubber-base paint will soften the first coat. Therefore, while the paint dries to the touch in a couple hours, it should be allowed 24 hrs. to dry before recoating. Even then it will pick up a little if brushed too much. If you spray, you don't have to worry about the pickup. Another tip on spraying: Don't try for perfect, solid coverage; it will dry better than it looks wet. The same also applies to brushwork. Rubber-base masonry paint does not show laps—you can start and stop as you please and double-coat at will with never a single telltale mark.

Rubber-base floor paint: The floor should be

Quick Data ON 5 CONCRETE PAINTS

14

KIND OF PAINT	WHERE USED	APPLICATION	COVERAGE		GENERAL FEATURES
			FIRST COAT	SECOND COAT	
CEMENT PAINT Powder form for mixing with water. Tints and white	Any porous masonry wall surface not previously painted: brick, concrete, cement stucco, cinder block. Not for floors	Stiff-bristle brush. Wall must be damp and paint sprayed with water after obtaining its initial set. Sand is added for cinder block	10 to 15 sq. ft. per lb. 75 to 125 sq. ft. per gal. (8 lbs. powder makes 1 gal. of paint)	15 to 25 sq. ft. per lb. 125-200 sq. ft. per gal.	Inexpensive. Excellent for cinder block and very porous concrete. Dries flat. Too brittle for floors. Can be sprayed only with agitating equipment. Suitable for new work after 10 days
RUBBER-BASE FLOOR PAINT Ready-mixed. Several colors, black, white	Especially for concrete floors. Works best on bare concrete but can be used over old paint	Brush or spray. Dries in 2-4 hrs. to touch but needs 24-hr. dry for second coat or service	About 300 sq. ft. per gal. on average surface	About 400 sq. ft. per gal.	Most expensive of concrete paints. Hardens dusty floors. Dries semi-gloss. Also suitable for wood. Free flowing, easy to brush. Second coat will pick up first coat unless thoroughly dry
RUBBER-BASE MASONRY PAINT Ready-mixed. Tints and black, white	Especially for walls, inside or out, on bare concrete or over old paint	Heavier than R.B. floor paint and needs thinning for spray application. Wall must be dry. One coat covers	About 250 sq. ft. per gal.	About 350 sq. ft. per gal.	Too expensive as first coat for cinder block. Needs 24 hrs. to dry for recoat, although dry to touch in 2 hrs. Flat finish. Good for asbestos shingles
OIL-BASE MASONRY PAINT Ready-mixed. Several colors, black and white	All masonry surfaces. Also is good general paint wherever flat finish is suitable	Brush or spray. Some products require primer coat	About 250 sq. ft. per gal.	350 to 600 sq. ft. per gal.	Has tung-oil base which resists lime better than linseed oil but not as good as rubber base. May be flat or gloss depending on make. House paint with tung oil is equivalent
EXTERIOR RESIN EMULSION Paste form mixes with water. Tints and white	Bare or painted masonry inside or out except floors. Do not use where mildew is present	Brush or spray. Second coat should be applied 8-12 hrs. after first. Not proof against rain for 12 hrs.	About 300 sq. ft. per gal. of paste	400 to 450 sq. ft. per gal. of paste	Inexpensive. This is a breather-type paint and does not waterproof nor resist passage of water. Becomes translucent when wet. OK for new work after 30 days. Dries flat

Rubber-Base Paint
IS TOPS FOR FLOORS. IT HARDENS SOFT CONCRETE. ALL SOAPY OR SLICK FLOORS SHOULD BE ETCHED WITH A 10 PERCENT SOLUTION OF MURIATIC ACID. RINSE WITH WATER

EXTEND FLOOR COLOR UP WALL

WATCH OUT FOR DAMP PATCHES

dry. If it is soapy or oily, or if it has a very smooth, troweled surface, it should be etched with a 10 to 25 percent solution of muriatic acid. One gallon of this mix will etch about 100 sq. ft. Mop the acid liberally with a scrub brush or broom, scrub it just a little and let it fizz. Fifteen minutes does the job. Rinse well with water. Substitutes are Bowlene, Sani-Flush or similar products. Wet the floor with water first and then sprinkle the dry crystals. One can will do about 70 sq. ft.

After etching or washing the floor, allow two days dry. Keep your eye on wet spots and give them an extra drying with a heat lamp, Fig. 17. Rubber-base floor paint is thinner than masonry paint and can be sprayed from a pressure-feed gun at the consistency found in the can. It has the same feature of softening undercoats as the masonry paint, and this should be remembered when doing two-color work; allow plenty of drying time, and don't brush too much when applying one color over another. A simple and practical trim is obtained by running the darker floor color about 6 in. up the wall, as shown in Fig. 16.

Oil-base masonry paint: This term covers a wide variety of paints. Generally, it indicates a paint which is very much like house paint except it is usually a flat finish and contains a good percentage of tung oil. Tung oil resists the chemical action of lime in concrete much better than linseed oil, but not as well as rubber-base paint. On the whole, masonry paint is quite satisfactory for all outdoor work, where alkali action is less severe than in a damp basement where water and lime attack the paint film constantly from behind. Since products vary, can-label directions should be followed.

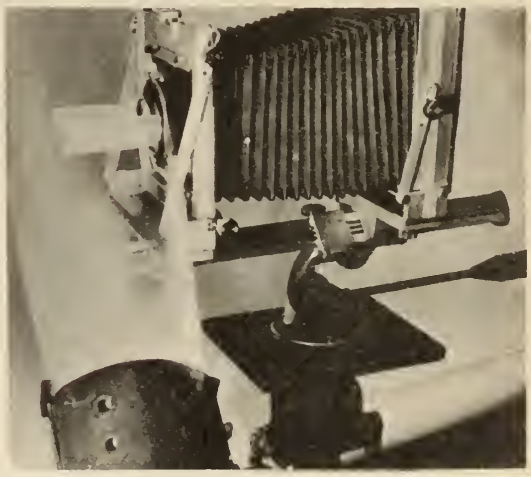
Exterior resin emulsion: If you have worked with interior water-mix paint, the exterior type will not surprise you much. You get it in paste form, mix with water, and then apply by brush or spray. This paint is not quite as good as rubber base, but if you like to paint every two or three years just for freshness, it makes an excellent, inexpensive finish.

Other products: Two other masonry-finishing materials are worth noting: hardeners and waterproofers. If your basement floor is dusting and you don't want to paint, you can obtain dry crystals or liquid hardener. The crystals mix with water; the liquid is ready to use. Both are clear finishes. Just broom the hardener on liberally and then sweep or squeegee to remove the surplus. Note that you don't need a hardener if you use rubber-base paint. The waterproofing referred to is a clear, penetrating liquid which goes deep into the masonry to make a permanent dry zone. You can paint over this waterproofing—it should not be confused with wax waterproofing which cannot be painted. Normally, most surfaces do not require this supertreatment.

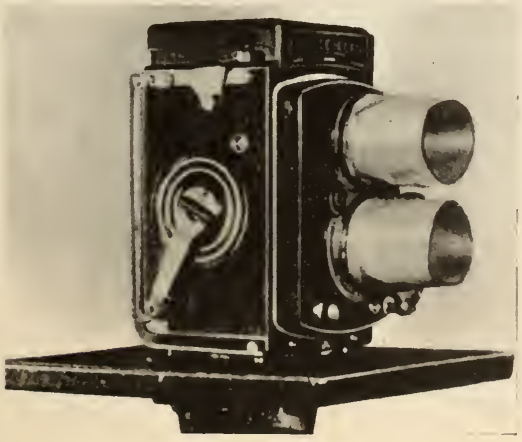
Light on lens shade of translucent paper produces "halo effect" as in portrait of pretty girl at left

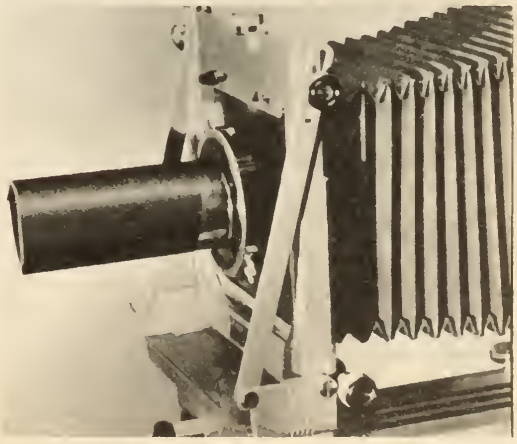
Special-Effects Lens Shades

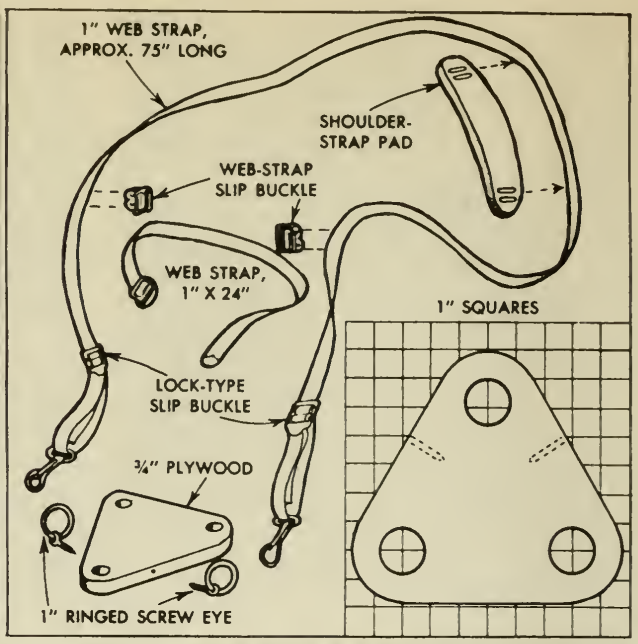
ALTHOUGH an ordinary camera-lens shade is adequate for normal conditions, more protection is required when making studio shots where brilliant highlighting is employed. One photographer improvises a more effective shade by using a cylinder of dull-finish black paper, as in the lower right-hand photo. For an ethereal effect, in which the subject seems to be rising out of a mist, a partial cylinder of translucent paper is fitted around the lower two thirds of the lens, as in the middle right-hand photo, and a small spotlight is focused on it. For a full vignette effect, a complete cylinder of the translucent paper is used, as on the portrait camera in the upper right-hand photo and the reflex-type camera in the lower left-hand photo. The portrait of the pretty girl was taken with this latter method, showing the "halo light" result.—Graphic House, Inc., New York City.



Above, partial cylinder of translucent paper provides "ethereal" effect. Below, cylinder of black paper shields camera lens against studio lights. Below, left, reflex-type camera needs two cylinders







Shoulder-Strap TRIPOD CARRIER

BESIDES PROVIDING a most convenient way of carrying a tripod and camera when out on a movie-making jaunt, this shoulder-strap carrier permits me to use my tripod as a unipod in a jiffy for on-the-spot shots of sporting events which demand steady camera support. In addition, I can quickly change over from a unipod to an extended tripod by merely lifting the tripod out of the carrier.

The triangular-shaped carrier is cut from a scrap of ¾-in. plywood. While a pattern is given, actual over-all size must be determined by the tripod at hand. Since mine has tubular legs I drilled holes for the legs, but if you happen to have a wooden tripod with square legs, square openings can be jigsawed in the carrier. In either case, the spacing of the holes should be such as to permit a slight spread to the tripod for better stability. The web strap material and fittings can be purchased at most sporting-goods stores. The drawing shows what the complete strap assembly looks like, two slip buckles being attached to the main strap for a short safety strap which is used to prevent the camera from tipping forward when used as a unipod. To tote the tripod from the shoulder the safety strap is removed from its unipod position and used to lash the carrying strap to the tripod head, thereby forming a shoulder sling as shown in the photo above. The inset photo shows how the carrier lies flat against the body when the tripod is removed.

Suspended from the neck, the carrier provides stable support for the tripod when used as a unipod. The use of the tripod head for both upward and downward angles is retained by merely reversing the direction of tripod head

Traveling-Kit Gadget Bag

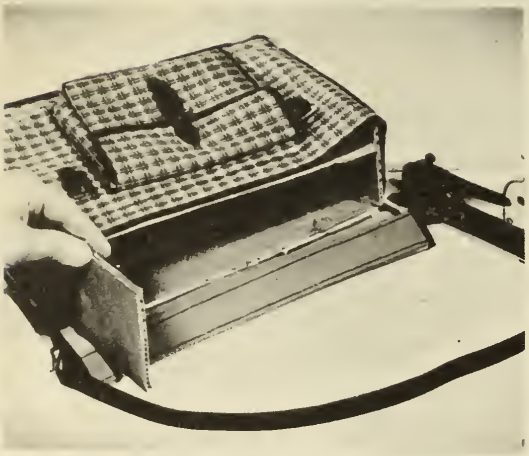
By Ken Patterson

EASILY CARRIED in one hand, this gadget bag will hold enough 35-mm. film for a full day of shooting, plus several filters, a photo guide booklet and a package of small-size flash bulbs. The bag is made by modifying a man's travel kit, first cutting off any straps inside. A strip of ⅛-in. hardboard then is drilled to accept five metal film containers, which are cemented in the holes. This assembly is cemented to the center of the opened kit. Filter containers also are cemented directly to the inside of the kit. Holes punched in the inner lining permit rubber bands to be threaded through to hold the guide book and the flash-bulb box. One end of the latter rests on a wooden block cemented to the case, permitting the inner slide of the box to be pulled out more readily and also to clear the filter case that is positioned opposite one end of the box. Note that the filter containers and box of flash bulbs are positioned so they are above the film containers when the kit is closed.

Wooden block is positioned so end of flash-bulb box rests on it, permitting easier removal of inner slide

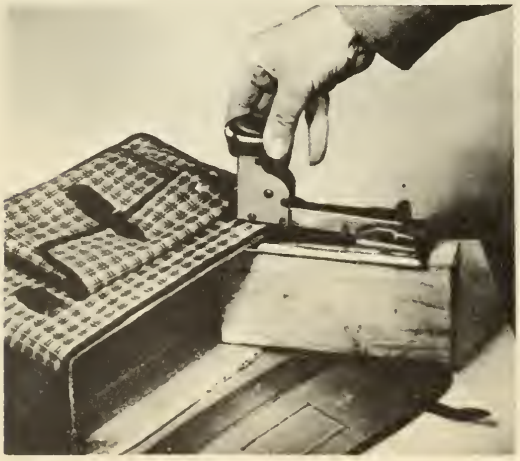
Film containers first are cemented in holes in strip of hardboard, then this assembly is cemented to kit

TOTE BAG
FOR SHUTTER BUGS



FROM SCHOOL BAG to camera gadget bag in a few minutes—it's as simple as that to convert an inexpensive plastic bag to accommodate a camera, flash equipment, tripod, light meter and extra film. Any school bag having a shoulder strap will do for this purpose. The conversion consists of backing up the bottom, sides, front and back of the bag with pieces of corrugated cardboard to stiffen it. A piece of foam rubber cemented to the bottom cardboard helps to protect the camera and meter from shock or jolting. Note how a wooden block is used to support the stapler at the right height when fastening the cardboard to the bag.—H. Leeper

Above, first step of conversion is to cut cardboard stiffening pieces to fit snugly inside of bag at bottom, sides, front and back. Below, block is used to hold stapler in position while fastening cardboard

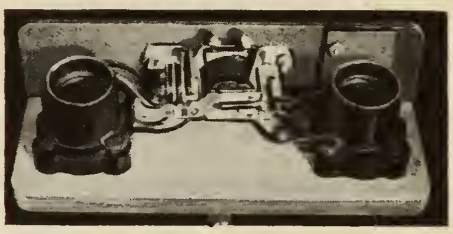


Piece of foam rubber is cemented to bottom piece of cardboard, which is then cemented to bottom of bag to provide cushioning for camera and meter. Cardboard lining may be finished with a coat of liquid rubber

PILOT FLASH
for PORTRAIT WORK

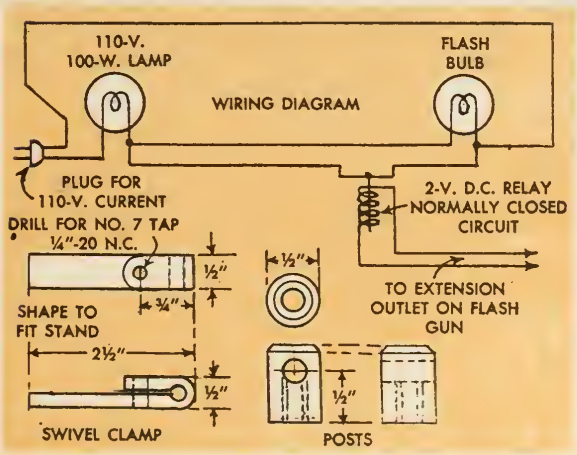
BEING ABLE TO OBSERVE beforehand the lighting effect on a subject when using a flash is a great help in taking portraits, especially of children. This is made possible with a unit the author calls pilot flash. It consists of a relay and two sockets of the cleat-receptacle type, the latter being wired in series to hold a flash-bulb adapter and a 100-watt bulb. The unit is mounted on a light stand, plugged into the 110-volt line, and used remotely from the camera. In use, the relay is opened by the current from the flash gun and the flash bulb fires. Then the relay closes and remains closed until the flash gun is fired again. This shorts out the flash-bulb socket, allowing a new flash bulb to be inserted in the socket without danger of firing. The 100-watt pilot light burns continuously except for the split second when the bulb fires. This arrangement tends to reduce the brilliance of the flash which startles children, since to them the light of the pilot bulb simply seems to become brighter momentarily and then to dim.

If your camera is equipped with a synchro-shutter, it will not be necessary to have a second flash gun. A double extension outlet can be mounted on the camera and both shutter cord and relay cord plugged into it. When this is done, it is advisable to add a couple of flash-gun dry cells to the pilot-flash unit to operate the relay. It is advisable also to put a midget connector in the relay cord to avoid plugging the relay into the 110-volt line since this would burn it out. Use a 100-watt bulb as it allows about one ampere to pass which is advisable where flash bulbs are fired in a 110-volt circuit.

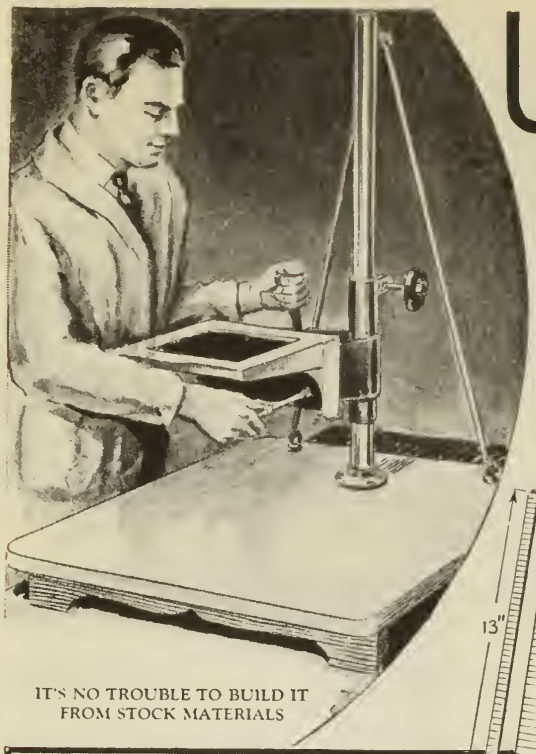


Above, a 2-volt, single-pole, double-throw photo-flash relay having a d. c. coil is required in addition to two plastic cleat sockets. These are screwed to an L-shape wooden base, 8 in. long

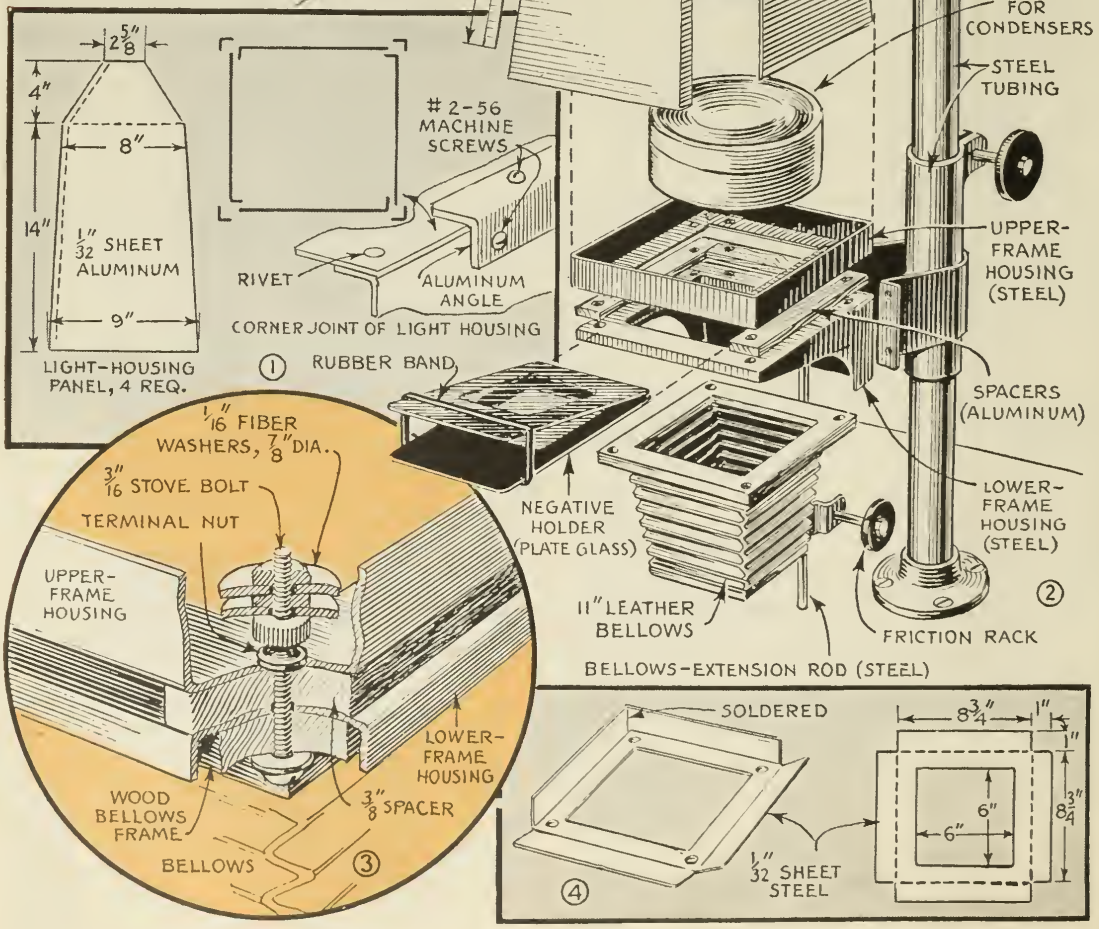
Above, unit is attached to light stand with modified swivel clamp. Note midget connector in relay cord. Below, Graflite bayonet shutter cord plugs into receptacle on camera



UNIVERSAL



IT'S NO TROUBLE TO BUILD IT FROM STOCK MATERIALS



ENLARGER

. . . has an adjustable light and is designed to hold any one of three sets of lenses and condensers so you can enlarge negatives ranging from 35 mm. to 4 by 5 inches

By JOSEPH OTT

THE TUBING AND RODS FORMING THE COLUMN AND BRACES MAY BE CHROMIUM PLATED FOR APPEARANCE. THE HOOD IS ALUMINUM AND THE BASEBOARD IS EITHER PLYWOOD OR GLUED-UP STOCK

THIS photo enlarger has been especially designed for the individual builder, which means that the parts and materials used are easy to get and are inexpensive. The assembly has been so worked out that only a few common tools are needed to build it complete ready for work. As you will see from Figs. 1 to 4 inclusive, the greater part of the assembly calls for sheet metal. This reduces the necessary equipment needed for this work to a rule, a scriber, a pair of tin snips and a few blocks of hardwood to serve as forming dies. In certain details and in the material list the dimensions given are only close approximations because of the necessity of bending and fitting a number of parts.

Now, to be truly universal in scope, an enlarger should accommodate, with simple adjustments, all film sizes ranging from 35 mm. to the popular large size, 4 by 5 in. This enlarger accommodates these and other intermediate sizes. To cover the three film sizes mentioned, it is necessary to have three different focal-length lenses with three matching sets of condensers, that is, the focal length of each lens should match the focal length of the companion set of condensers. If the enlarger is constructed to take the 4 by 5-in. film with matching focal length lens and condensers, the smaller lenses and condensers can be interchanged easily. For the 1 by 1½-in. or 35-mm. film, a focal length lens of 50 to 75 mm. will be required. Condensers to match should be approximately 3 to 3½ in. in diameter. The intermediate size of 2¼ by 2¼ in. should have a lens of approximately 4 to 4½-in. focal length and condensers to match should be approximately 5½ in. in diameter. For the larger size of 4 by 5 in. the focal length of the lens should be approximately 5¼ or 6 in. and the condensers 8 in. in diameter. The condensers when paired and placed in a frame, with convex sides facing, should give a focal length equivalent to the focal length of the lens. The above condenser diameters give the required focal length for the lenses mentioned. When the focal lengths of condensers and lens match, focusing of the image is sharp and the distribution of light to all corners is uniform. This equal distribution of light is very essential in practice. The reason for having condensers and lenses of various sizes is to shorten the movement of the enlarging unit.

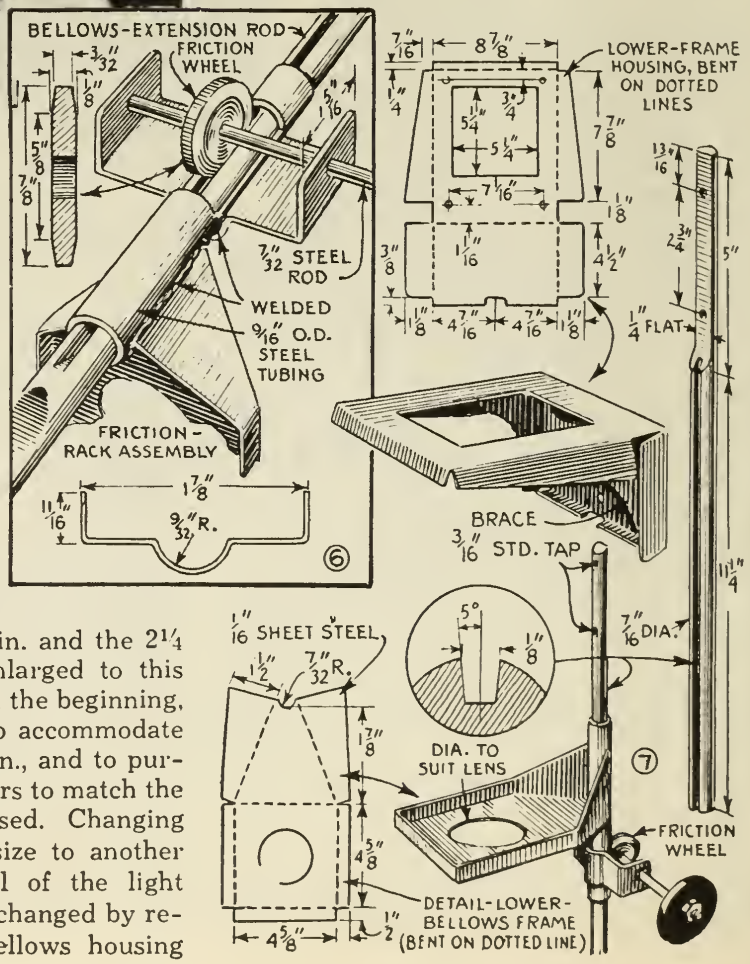
A 1 by 1½-in. film can be placed in the 4 by 5-in. film holder and focused through the 8-in. condensers and 6-in. lens but it would be necessary to raise the enlarger to a height of from 6 to 10 ft. above the

DOUBLE CONDENSERS GIVE HIGH ILLUMINATION FOR CRITICALLY SHARP FOCUSING AND SHORT EXPOSURES

enlarging board. In most cases only a small part of the negative is used and it would be impossible to operate the enlarger because of the height necessary to secure the desired enlargement. This enlarger is designed to operate on an upright 42 in. high, which allows the image of a full 4 by 5-in. film to be enlarged to approximately 20 by 30 in. and likewise the 1 by 1½-in. and the 2¼ by 2¼-in. films can be enlarged to this same size. It is advisable, in the beginning, to construct the enlarger to accommodate the large-size film, 4 by 5 in., and to purchase the lens and condensers to match the particular size film you used. Changing the condensers from one size to another requires only the removal of the light housing and the lenses are changed by removing from the lower-bellows housing as in Fig. 12. Flanges of different sizes can be fitted into the housing.

Provision is also made for the use of a ground or opal glass in place of condensers. Although certain advantages are claimed for the ground-glass diffuser, the amount of light necessary is approximately three to four times that required with condensers. Through ground-glass diffusion light falls off rapidly toward the edges and the image is not as sharp as with condensers. However, to reduce the cost of this enlarger, the builder can follow the general construction, using a ground-glass diffuser and a lens of the proper focal length. Later he may add matched condensers and still later other lenses and condensers to fit other films.

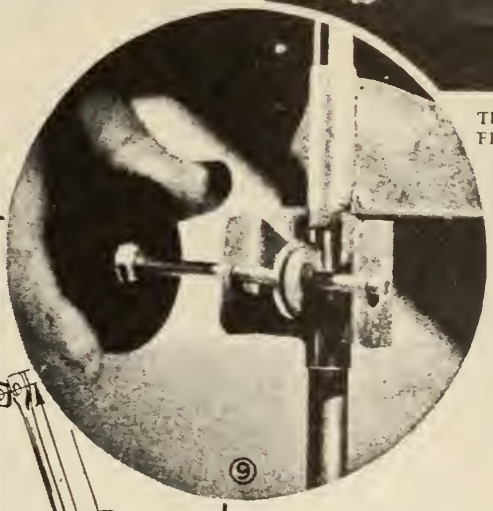
Now, in Figs. 5 to 11 inclusive you will find a number of the parts shown in Figs. 1 to 4 detailed separately. Although it is not especially important, proceeding to make the parts in a regular sequence will

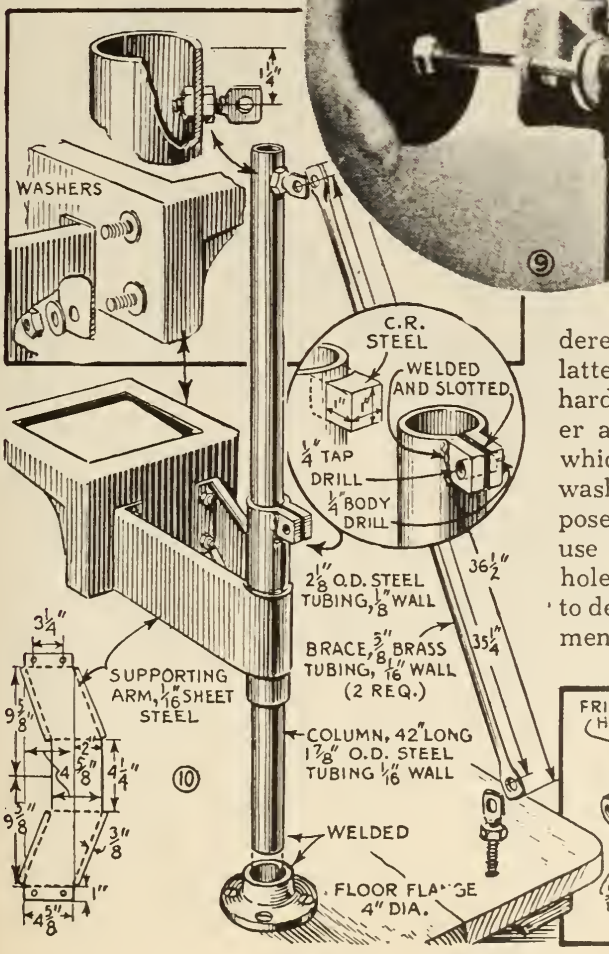


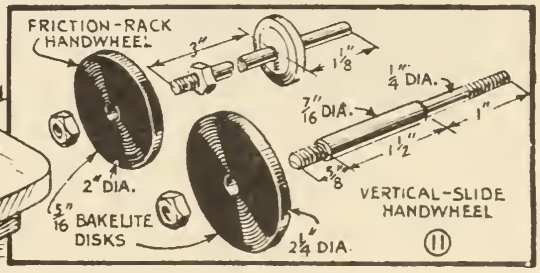
help in getting the assembly together properly. Although detailed last, it's a good idea to begin with the enlarging board or base, Fig. 13. This either can be built up as shown, or made from plywood of the same thickness. This done, set up the column and braces, Fig. 10, with the vertical sliding member and the supporting arm in place. Of course, this assembly must include the welds indicated. This means that the handwheel lugs and the supporting arm, Fig. 10, must be welded to the slide before it is slipped over the column. Finish this job with the vertical-slide handwheel, Fig. 11.

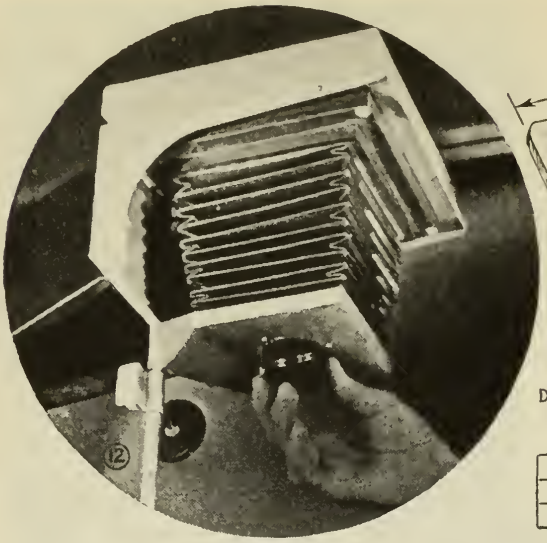
Now back to Fig. 1 and from this assemble the light housing complete. Then before you make the upper-frame housing, Figs. 2 and 4, check the dimensions at the lower end of the light housing to make sure that it will fit snugly into the upper-frame housing. You may have to alter the size of the latter slightly. With this housing made, follow with the lower housing, Fig. 2, and then cut the spacers to size. All joints on the two housings can be soldered. Although the specification of the latter calls for aluminum, you can use hardwood. Now clamp these parts together and drill the four holes for the bolts which join the parts as in Fig. 3. The fiber washers spaced as in Fig. 3 are for the purpose of holding a ground glass should you use one. Only the distance between the holes one way is given in Fig. 7. You have to determine the other spacing by measurement of the upper-bellows frame. Check

THE NEGATIVE HOLDER IS MADE FROM TWO PIECES OF PLATE GLASS HINGED WITH TAPE

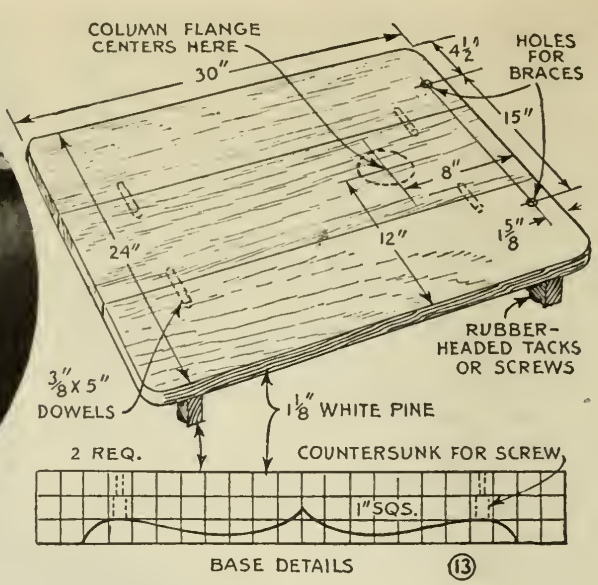








FOR VARYING SIZES OF FILM, SIMPLY CHANGE THE LENSES AND CONDENSERS



BASE DETAILS (13)

MATERIAL LIST

Part	Kind of Material	Quantity	Size
Enlarging board	Pine	1	1 x 20 x 30 in.
Brace	Pine	2	1 x 4 x 18 in.
Upright column	Steel tubing	1	1/16 x 1⅞ x 42 in.
Braces	Brass tubing	2	1/16 x ½ x 45 in.
Sliding column	Steel	1	10 in. long to fit over upright
Extension for housing	Steel sheet	1	1/32 x 5½ x 20 in.
Bellows	Leather	1	5 x 5 x 11 in. extension
Film holder	Plate glass	2	⅛ x 6½ x 9 in.
Lower-frame housing	Steel	1	1/32 x 10 x 14 in.
Upper-frame housing	Steel	1	1/32 x 11 x 11 in.
Spacers	Aluminum	3	⅜ x 1 x 9 in.
Top housing	Aluminum	4	1/32 x 9 in. at bottom 6 in. at top—20 in. long
Corner of housing	Aluminum	4	1/32 x 1 x 20 in.
Top of housing	Steel sheet	1	1/32 x 4 x 4 in.
Upright extension	Steel tubing	1	7/16 x 12 x 1/16 in. wall
Light socket	Standard	1	To fit enlarging bulb
Thumb setscrew	Steel	1	3/16 in. thread—⅝ in. knurled head
Bellows-extension rod	Steel	1	7/16 x 16¼ in.
Lower bellows frame	Steel sheet	1	1/32 x 5 x 8 in.
Handwheels	Bakelite	2	¼ x 3 in. diameter
Rack-wheel shaft	Steel	1	7/32 x 4½ in.
Tapered rack wheel	Steel	1	⅛ x ⅞ in. diameter
Rack spring	Steel	1	1/32 x 1-5/16 x 4 in.
Upright flange	Cast iron	1	¼ x 4 in. diameter
Anchor bolt	Steel	2	⅜ x 2 in. long
Flanged bolts	Steel	4	5/16 x 2 in. long
Finishing head	Wood-turned	1	To fit diameter of column
Rubber rests	Sunk screw and rubber	4	¾ in. diameter
Diffusion glass	(Or opal glass)	1	3/16 in. thick to fit frame
Extension cord, switch and plug		1	12 ft. long
Nuts and bolts	Steel	8	1½ in. long
Nuts and bolts	Steel	3	¾ in. long
Rod	Steel	1	3/16 x 4 in.
Rod	Steel	1	½ x 4 in.
Housing-assembly screws	Steel	36	Size No. 2-56

this before drilling any of the holes. Note also that in Figs. 2 and 10 the lips or "ears" of the supporting arm are shown bent in opposite directions. On the original the lips were bent inward but, due to the weld at the tubular slide, it may be necessary to bend them outward as in Fig. 2, when fitting the parts together.

With the assembly at this stage you're ready for the lower-bellows frame and the friction-rack assembly, Figs. 2, 6, 7 and 9. This is a bit more exacting and several machine operations are necessary. It's especially important that the sides of the groove milled in the bellows-extension rod be inclined approximately 5 degrees and that the sides of the friction wheel be machined to correspond. Of course, some filing and trial fitting will be necessary after you cut out the lower-bellows frame or housing, Fig. 7, as the dimensions are only ap-

proximate. The complete assembly is shown in Figs. 6 and 9. The rack spring mentioned in the material list is dimensioned in the lower detail in Fig. 6 and shown in place in the upper detail. Bent to the shape shown and drilled, it provides tight bearings for the friction-rack handwheel, Figs. 6 and 11.

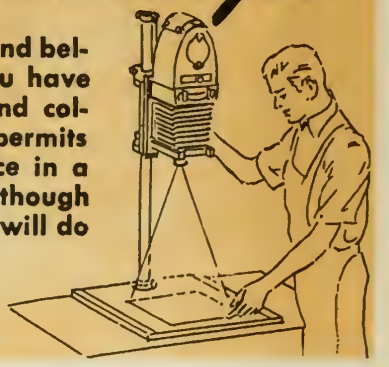
It should be noted in Fig. 2 that the enlarging bulb is placed in a socket attached to a tube which is adjustable through the top of the housing. When using condensers it is necessary to place the light far enough above the condensers to give uniform illumination. For this reason, the top of the housing for a 4 by 5-in. film is 18 in. above the negative. The enlarging lamp should be about 250 watts for a 4 by 5-in. film using 8-in. condensers. Without condensers a 1,000-watt light is required. For a 2¼ by 2¼-in. film with condensers, a 100 to 125-watt lamp is sufficient and for the 1 by 1½-in. film, approximately 60 watts.

UNIVERSAL FLASH-GUN CORD

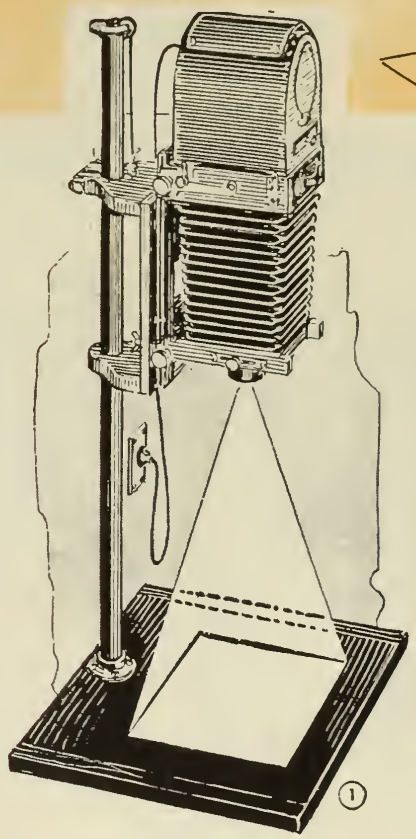
Most professional photographers have more than one camera as well as several lenses for each one. Their choice of lenses and shutters varies to suit their particular fields, but not all shutters have the same flash contacts. This means that separate cords are required for each camera, and since two separate lengths of cord are also required—a short one for on-camera work and a long one for off-camera work—the photographer is burdened with many cords. To lessen the number of cords needed, one *PM* photographer fitted a jack to the end of each short cord so it could be plugged into a single universal cord which was fitted with a matching plug. The plugs and jacks are available at most radio supply houses and consist of two halves which are cemented together after the prongs are carefully soldered to the bared ends of the flash-gun cords. It is well to test the connections before cementing the two parts of the jacks together. This can be done with a continuity tester or simply by trying to fire a flash bulb. An added advantage in using the jacks is that in case of an accident where the flashgun might fall, the plugs and jacks will separate right away before the flash contacts will pull off the shutter housing and be damaged.

Camera Becomes Enlarger

Your camera supplies the lens and bellows for this enlarger — all you have to make is the lamp house and column. Quick-change adapter permits camera to be clamped in place in a jiffy. View camera is preferred, though most any folding-type camera will do

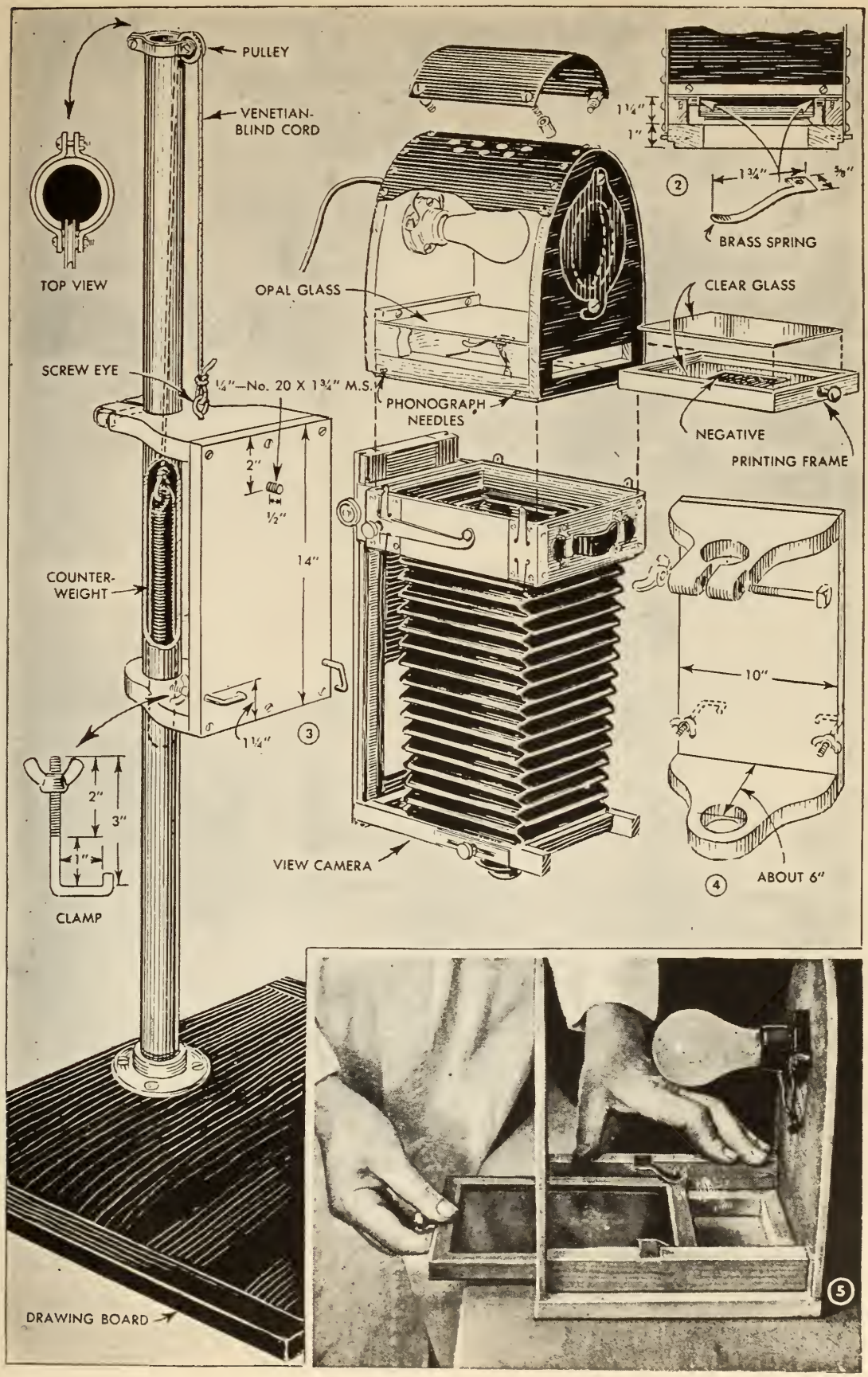


IF YOU have a bellows-type camera, it's likely that it can be used as an enlarger simply by removing the ground glass and constructing a lamp house and column to fit. The enlarger described here, Fig. 1, was made with a 5 by 7-in. view camera, but others can be adapted by altering the size of the lamp housing, column and platform to suit your camera. It may be necessary, in this case, to experiment and determine the height of the standard and the position of the camera in relation to the enlarging board and the focal length of the lens so the negative is properly projected.



Two pieces of plywood form the ends of the lamp house and are cut in the form of a parabola. Only the part that shapes the contour of the sheet-metal reflector need be a true parabolic curve, however; the rest is straight. Cut a 5-in. circle in one piece and fit it with a sheet-metal access door as indicated in Fig. 2. This is provided for the removal of the lamp. In the same piece cut an opening for the negative holder, which may be a contact printing frame of a size to fit the camera. The lamp base is mounted on the other endpiece and a hole is drilled above the socket for the lamp cord. The lamp should be centered so light is distributed uniformly over the opal glass. This can be checked with a light meter as in Fig. 6. The hardwood sidepieces that serve as guides for the negative holder, Fig. 5, are cut and fitted with spring clips, right-hand detail of Fig. 2. Place the opal glass and secure it with two small strips on the endpieces. After the ends and sidepieces are assembled, the sheet-metal cover is added. To provide adequate ventilation, holes are drilled in the top. A baffle is provided for the ventilation holes and is held in place with spacers and machine screws. The interior of the house is finished with aluminum paint. After rabbeting the ends and sidepieces to fit the back of the camera, drive in phonograph needles to engage the ground-glass retaining clips. If you use a contact printing frame as a negative holder, Fig. 5, remove the back and any clips on the sides that may have been used to hold the back in position. A knob is added to remove and insert the holder. Two sheets of plate glass are cut to fit the holder and the negative is carried between them. If desired, a set of masks can be made for different sizes of film down to 35-mm. film. Paint all exterior parts of the lamp house a dull black.

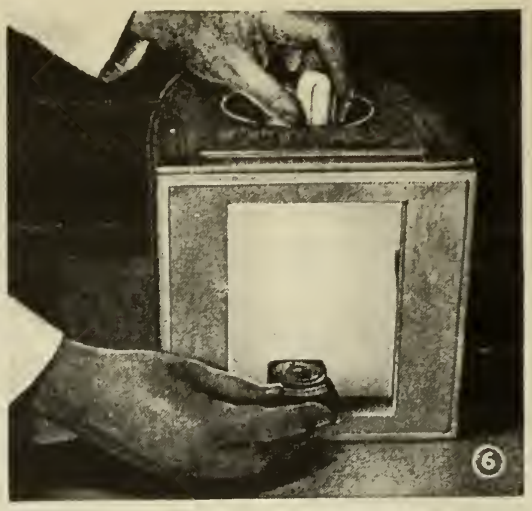
To make the camera platform and column, cut a piece of 1¼-in. pipe—48 in. long in this case—and thread one end. Notch the other end and fit it with a collar and pulley as in the upper detail of Fig. 3. The platform consists of a base and the two endpieces, Fig. 4. The lower piece serves as a guide only, and the upper piece, which is slotted, clamps the platform in position when the wing-nut-and-bolt adjustment is tightened. The camera is held in posi-


PULLEY
VENETIAN-BLIND CORD
TOP VIEW
OPAL GLASS
SCREW EYE
¼"—No. 20 X 1¾" M.S.
PHONOGRAPH NEEDLES
CLEAR GLASS
NEGATIVE
PRINTING FRAME
2"
½"
14"
COUNTER-WEIGHT
1¼"
3
2"
3"
1"
CLAMP
VIEW CAMERA
1¼"
1"
2
1¾"
⅜"
BRASS SPRING
10"
4
ABOUT 6"
DRAWING BOARD
5

tion on the platform by means of a ¼-in. No. 20 tripod screw, which fits the tripod base, and two adjustable clamps that fit over the bed. Here again it will be necessary to take measurements from your own camera to determine the size of the platform and location of the screw and clamps.

When the platform is attached to the camera, it should be weighed and a lead counterweight made which rides inside the pipe, Fig. 3, using Venetian-blind cord to attach it. The weight should be equal to that of the camera and platform. This will make raising and lowering the camera easier. A suitable base for the enlarger is made from a drawing board of the type used by students. A 1¼-in. floor flange is screwed to the center of one side. The column is screwed into this. All exposed wood parts should be finished in a dull black color to prevent unwanted light reflections.

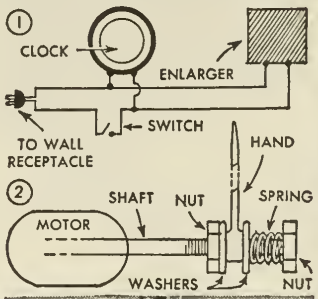
Although no particular type of switch is indicated, a snap switch can be installed in the cord, or, to leave both hands free, a foot switch can be used. The latter usually is



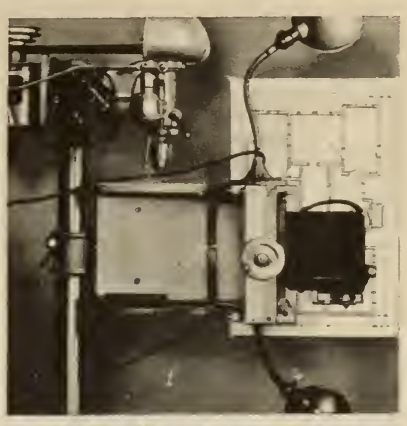
preferred. A standard enlarging bulb of the proper size for your lamp house should be used. Any enlarging easel will do as long as it fulfills the requirements of your work and is not too large for the platform.

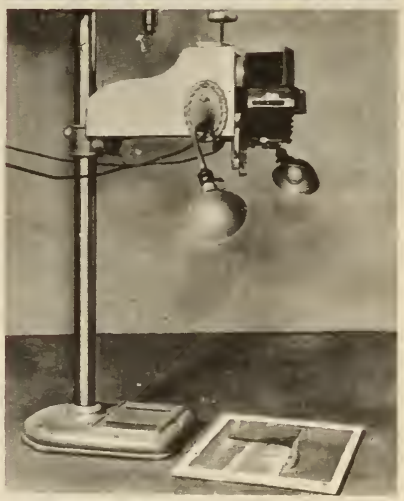
Photo Timer and Enlarger Operated Together

If a switch is connected in series with the enlarger and in parallel with the timer, detail 1, the two will operate simultaneously. Any self-starting electric clock is used for this setup. The minute and hour hand are removed, leaving only the second hand. With a little work a reset device can be installed. The motor is removed and the shaft is threaded. Then the hand is replaced and the two washers, nuts and spring shown in detail 2 are added. The knob and catch which are shown in the lower left-hand detail are for the purpose of returning the hand to the 12 o'clock position. In operation, the knob is pushed in against the spring so the catch will engage the hand, and when the hand is set and pressure is removed, the catch will spring back.



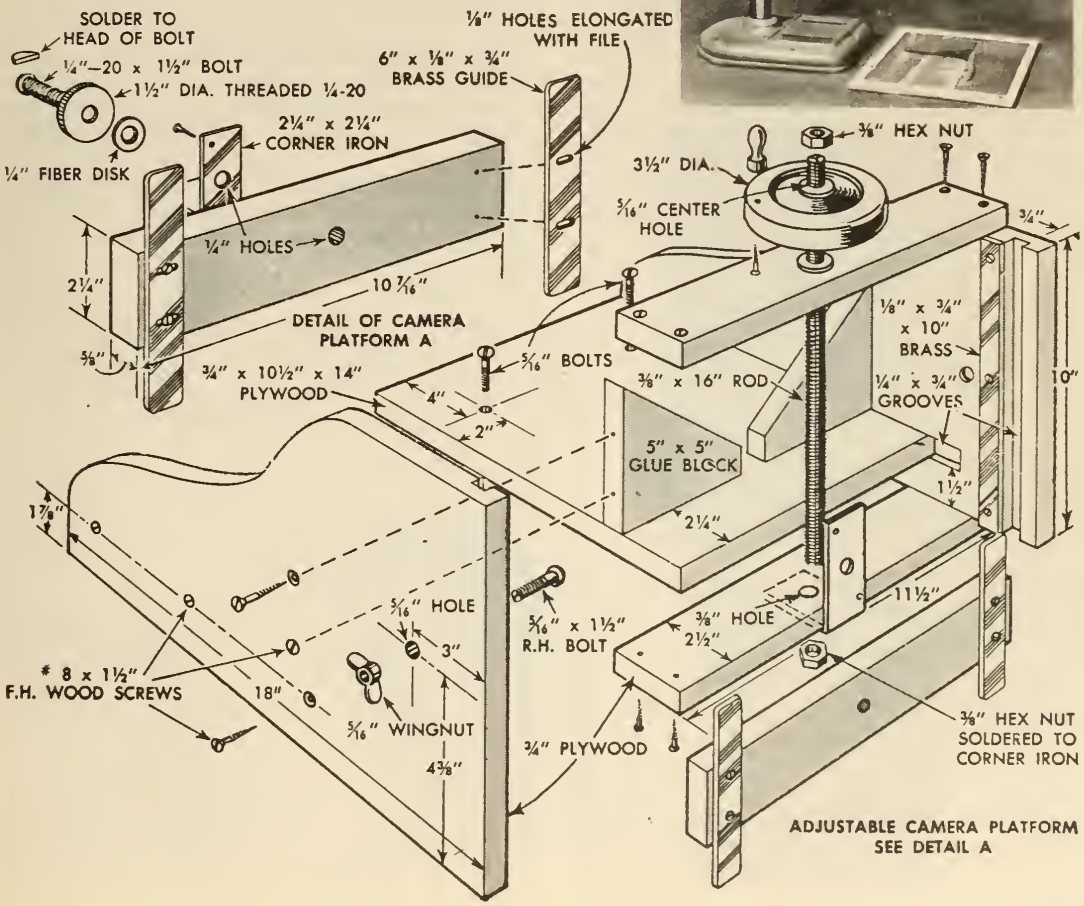
COPY-CAMERA MOUNT





ONE IMPORTANT REQUIREMENT for photographic copy work is a firm camera support. You can convert a drill press into a copying stand by adding this easily built attachment. For vertical copying, subject-to-camera distance is adjusted by sliding the table up and down the column. Finer adjustments within a range of 7 in. are made with a handwheel and screw arrangement. The mount is cut from ¾-in. plywood, the base fitting into horizontal grooves cut into the sides and secured with glue blocks and wood screws. The adjustable camera platform, detail A, operates by means of a ⅜ x 16-in. threaded rod running vertically through two cross braces. These are secured horizontally to the front top and bottom of the mount. The rod is turned by means of a hand wheel and screws through a ⅜-in. hex nut soldered to an angle iron fitted to the bottom brace. The brass guides on either side of the platform move in ¼ x ¾-in. grooves cut into the sides of the mount, and the camera is secured to the platform with a bolt screwed into the camera's tripod attachment. Any play in the platform is taken up by the four metal guides which are adjusted for a good sliding fit.

Howard R. Clark, Springdale, Ark.



Calibrate Your Enlarger

By Joseph Foldes

WHEN MAKING several different sizes of enlargements from the same negative, considerable time and darkroom materials can be saved when you work with a calibrated enlarger and use the table of enlarging ratios shown below. You then will get good quality prints having consistently uniform tone values, Fig. 1, without having to make several test strips for each change of print size.

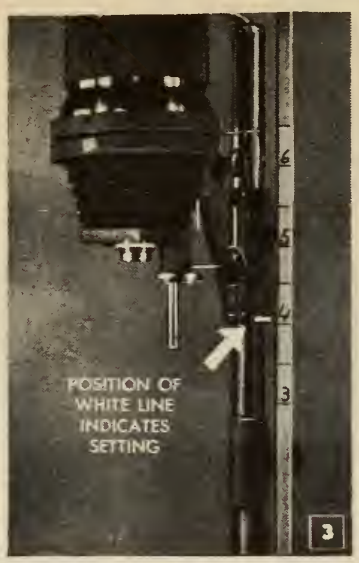
Calibration Scale

First, make the calibration scale, so that you know how many times (diameters) a negative is being enlarged. To establish the number of times of enlargement for any one position of the enlarger head, draw a line 1 in. long on a piece of clear negative or tracing paper as shown in Fig. 6, and place it in the negative carrier. Focus the line on the easel with the enlarger head lowered to give the minimum number of times enlargement to the nearest half unit. Then, raise the enlarger head and mark each intermediate position on the upright or support—2, 2½, 3, 3½, etc., until the enlarger is as high as it will go. If more than one lens is used with the enlarger, a different scale must be made for each of them. The aperture must be the same for all tests and prints.

Fig. 2 shows a calibrated Omega DII enlarger with a strip of white adhesive tape attached to the right-hand supporting beam and the calibration scale marked on the tape in India ink. Select any part on the enlarging head that slides on the upright

Enlarging-ratio numbers are number of times (diameters) projected image is larger than negative

Enlarging ratio as read on calibrated enlarger	Guide No.	Enlarging ratio as read on calibrated enlarger	Guide No.
1½	1	8½	14.5
2	1.5	9	16.5
2½	2	9½	18
3	2.5	10	20
3½	3.5	10½	22
4	4	11	23.5
4½	5	11½	25
5	6	12	27
5½	7	12½	29
6	8	13	31
6½	9	13½	33.5
7	10	14	36
7½	11.5	14½	38
8	13	15	41



When calibrating enlarger like Omega DII, Fig. 2, attach scale to upright. Fig. 3, affix scale on wooden strip for other enlargers. Fig. 4, 1-in. line on negative projected on easel determines the enlarging ratio

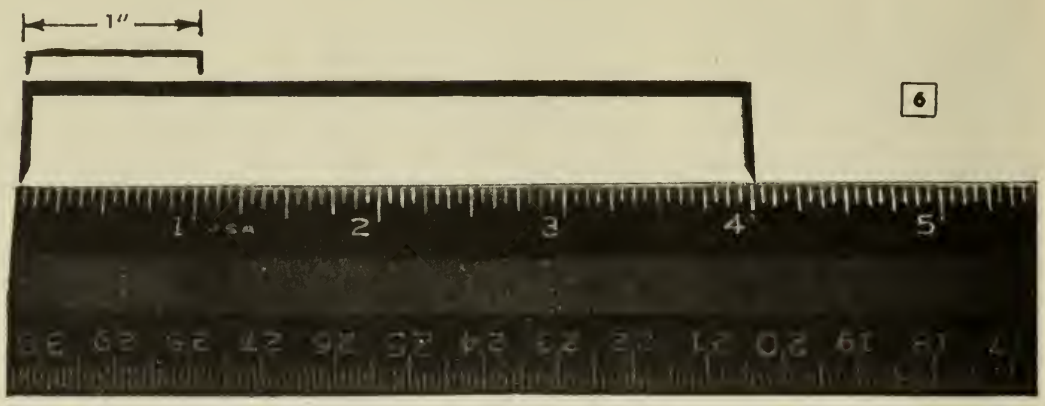
and scribe a pointer or index line on it for use as a point of reference when adjusting the enlarger to the desired setting. For the Omega DII enlarger, the upper edge of the locking block is used as a pointer. Since it has a light-colored surface, a black line is painted along the upper edge for easier reading.

On some enlargers it is impossible to attach a suitable material on the upright for marking the scale because it would interfere with raising and lowering of the enlarger head. In this case, mark the scale on a thin strip of wood and hold it next to the upright each time a setting is changed as shown in Fig. 3, or fasten the strip to a wall bracket positioned so that it is adjacent to the upright for easy reading.

Correct Exposure

To get the proper exposure for any size enlargement, first make a print by the test-strip method, noting the number of times of enlargement and exact exposure time required for a good quality print. Look up the guide number for the test print you have just made, using the table shown and then the guide number for the enlargement about to be made. To arrive at the new exposure, multiply the new guide number by the exposure in seconds of the test enlargement. Then divide the result by the old

5 **Determining right exposures for different size enlargements by test-strip method, or by guess, often results in prints that are over or under-exposed as shown in photos below. Use of calibration saves time and assures uniform exposure**



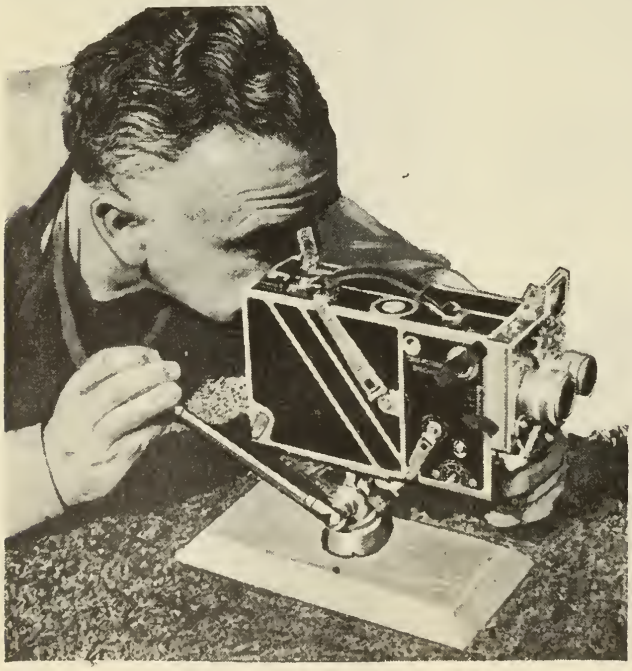
To establish number-of-times enlargement for any one position of the enlarger head, project a 1-in. line (drawn on clear negative or tracing paper) on easel. The 4-in. line above indicates 4-times enlargement

guide number which will give the correct exposure in seconds for the new enlargement. The same procedure applies if the print is larger or smaller than the first (test) print. When an exposure is made with the enlarger head set between lines, 5½ and 6, for example, make a corresponding adjustment in the guide number.

Variables That Affect Prints

Since the speed or scale of contrast varies with the different types of papers, it is necessary to make one test print for each type and grade. The speed of even the same paper may vary somewhat if it is taken from a different lot, making it necessary to run a test print beforehand for good results.

The illumination and optics used in an enlarger may introduce slight variations, but they are usually insignificant. If it is found that your enlargements turn out consistently darker or lighter than the test print, make an allowance for it by increasing or decreasing the new exposure slightly as the case may be. Other factors entering into the determination of length of exposure are density of negative, color of negative and duration of development. Negatives of medium density and with good tone values simplify developing work. Also, follow through with accurate and uniform timing when processing prints. ★ ★ ★



Camera Floor-Pod

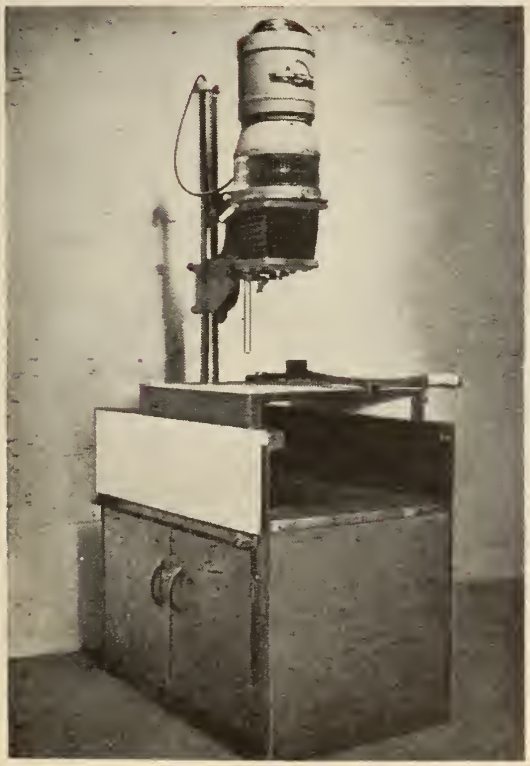
An indispensable accessory for shooting low-angle movie scenes is a camera floor-pod like this one. Being nothing more than a board measuring 5 x 10 in. and fitted with a ¼-20 bolt for attaching the pan head, it is an accessory that is easily made and one which will provide firm support for low panning shots. The hole for the bolt head should be countersunk on the underside of the board so the bolt head will be flush with the surface. Where steeper low-angle shots are required than are possible with the tilt head, the front end of the wooden base can be blocked up with a book or other flat object which will provide stable support to prevent rocking.

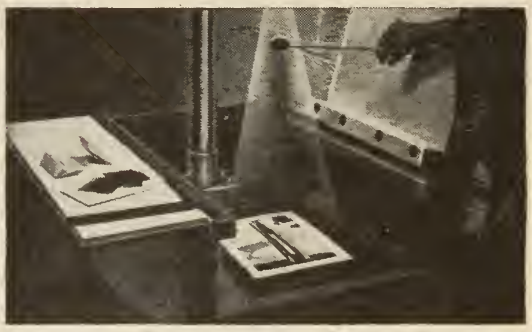
CABINET for your ENLARGER

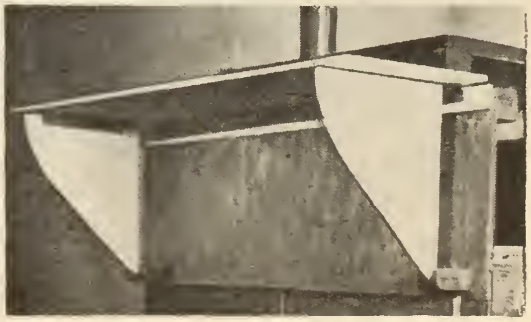
By Robert E. Dalton

TWO UNUSUAL features make this enlarger cabinet especially adaptable to use in basement or closet darkrooms where height and floor space are limited. Use of the cutting board, or trimmer, as a supplementary easel gives two easel heights with relation to the floor and also two projection distances in relation to the enlarger. The trimmer is hinged to the cabinet side-panel extensions and swings out of the way when not in use. Loose-pin hinges permit its removal when desirable. A hinged drop leaf, supported by hinged wings, is attached to the opposite panel extension as in the lower right-hand photos.

The cabinet, detailed on the opposite page, is made from ¼-in. plywood and 2 x 2-in. stock for framing in the manner shown. In the detail, the plywood bottom has been omitted for the sake of clarity. This is



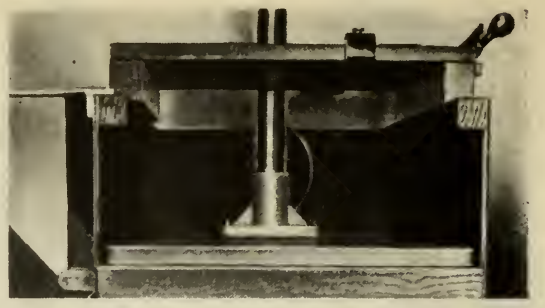




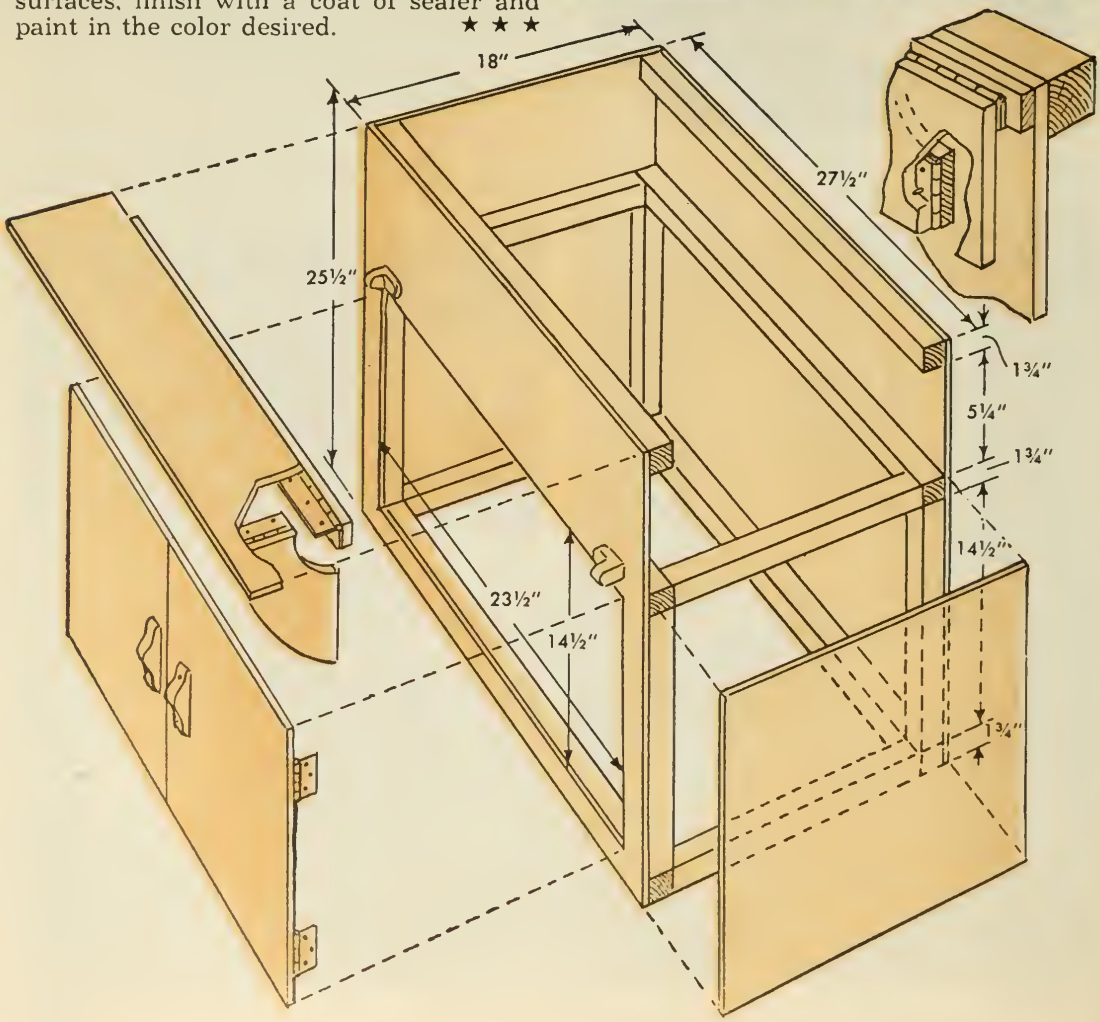
Photos above, left and below picture the convenience features of this enlarger stand which has been designed and built for use in limited space. Note use of trimmer as an auxiliary easel, also folding shelf

of ⅝-in. plywood which is of sufficient rigidity to support the weight of a printer and other items which may be stored in the lower compartment. The top of the cabinet, which is about 5¼ in. below the top of the extended side panels, also is of ⅝-in. plywood. For a heavier enlarger, use ¾-in. plywood. Parts can be joined with nails, but the use of screws and glue will result in a much more durable and rigid cabinet. Doors are of ⅜-in. plywood and are hinged to fit flush in the opening to the compartment. Friction cabinet-door catches hold them in the closed position. Note that the folding leaf must be set out the thickness of the wings by means of a strip as in the upper right-hand detail. Note also that it swings on a continuous, or piano-type, hinge. This prevents the leaf from sagging at the center. The trimmer is hinged to the opposite panel of the cabinet and swings up and over so that it does not interfere when using the regular easel.

The dimensions given are those of the original cabinet. These can be altered proportionally if desired. Sand all exposed surfaces, finish with a coat of sealer and paint in the color desired. ★ ★ ★



Above, a front view showing how the enlarger easel fits into the upper open-end compartment of the cabinet. Below, the folding shelf, or leaf, swings on a piano-type hinge to prevent sagging at the center



DENSITOMETER Speeds Photo Enlarging

By E. H. Leftwich

FOR THE amateur photographer who prefers to do his own photo enlarging, here is an inexpensive, easy-to-build electronic unit that will save darkroom time and cut waste of enlarging paper. The unit simply measures the degree of contrast between the lightest and darkest areas of a negative so that it can be classified in one of the five groups shown in the sample negative-contrast ratio table, Fig. 5, and a proper exposure time determined.

The exposure time listed opposite each of the five contrast ratings in Fig. 5 applies to a specific type of enlarging paper, developer and the developing time recommended for the developer. However, it takes only a few minutes to determine these values for the type of paper and developer you use. To do this, the following procedure is recommended:

1. Place the negative to be classified in the enlarger, focus and set the aperture of the enlarger lens at f:11.

2. Remove the protective cap from the photocell (PH-1, Fig. 2) and hold the latter on the easel in the lightest area (shadows) of the projected image. With the power button, Fig. 1, (SW-1, push switch, Fig. 4) depressed, set the sensitivity control so that a reading of 40 is obtained on the microammeter as shown in the illustration at the upper right.

Below, plastic bottle cap is used to cover "eye" of photocell when latter is not in use to protect it from dust

LIST OF MATERIALS

RESISTORS — all ½-watt (K=1000 ohms) R-1=22K; R-2=1 meg.; R-3=12K; R-4=100K potentiometer, Mallory type linear taper, U-41.

CAPACITORS—C-1=1 mfd., 400-volts, Cornell-Dubilier.

MISCELLANEOUS—T-1=Power transformer, sec. 500 volts-20 ma. and 6.3 volts-2 amp. Triad-type R-3A (use one half of rated 500 v.); UA=microammeter, 0 to 50 microamperes, GE or equivalent; REC. REC=(two) selenium rectifiers, Federal miniature-type 1263A, 65 ma.; SW-1=push-button switch, Grayhill-type 4001; SW-2=2-position rotary switch, Mallory-type 3142J; PH-1=photocell, Clairex-type CL-1; VR-1, VR-2=voltage-regulator tubes (optional), Mallory-type 6308; PL=pilot lamp, 6 or 8-volts.

HARDWARE—terminal strip, 9-terminal, chassis mtg.; utility cabinet, ICA-type 29812; dial plate and pointer knob for R-4; 10-ft. line cord; 10-ft. No. 18-7 tinned copper hookup wire; 2 rubber grommets, ⅜ x ½-in.; 1 pkg. single tie points; handle for utility cabinet.

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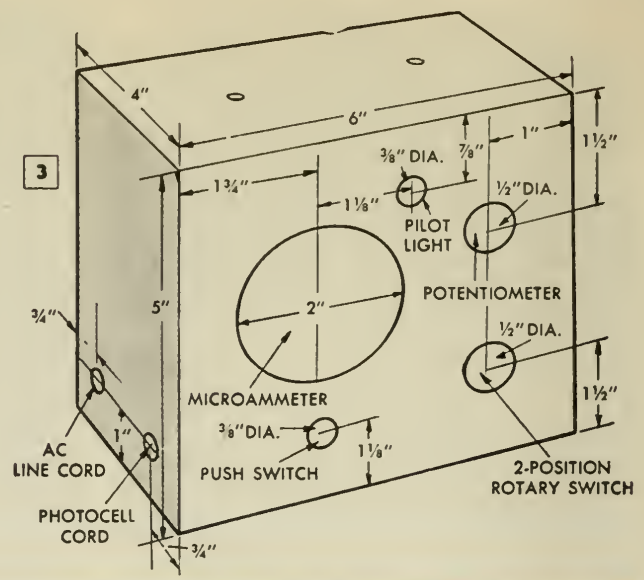
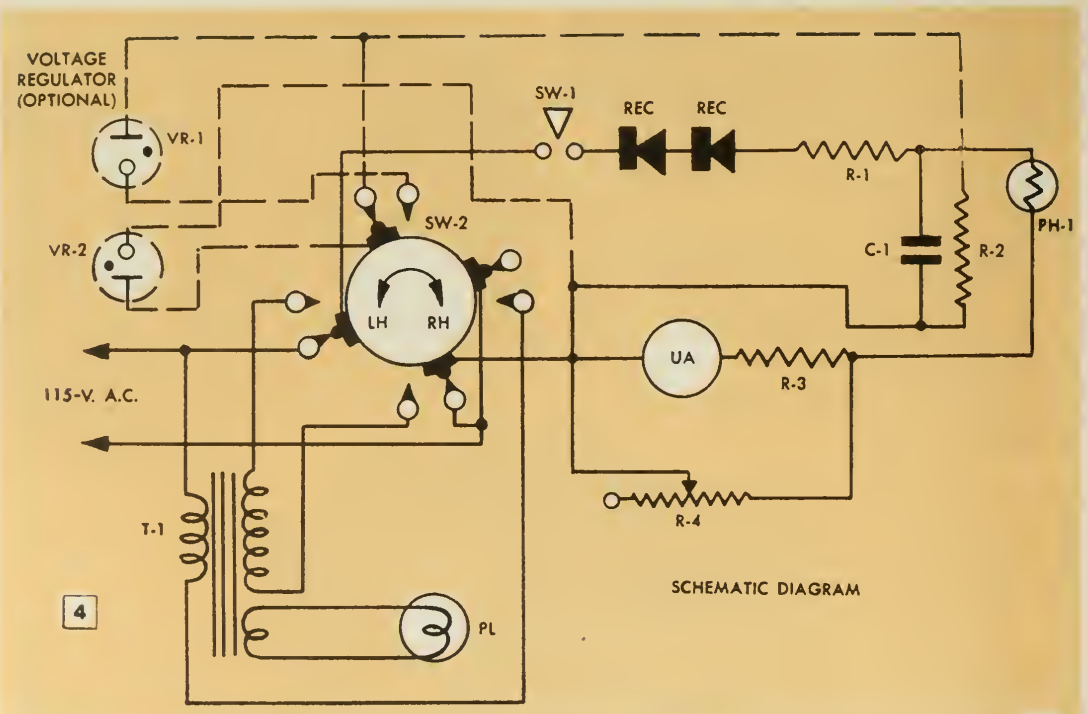




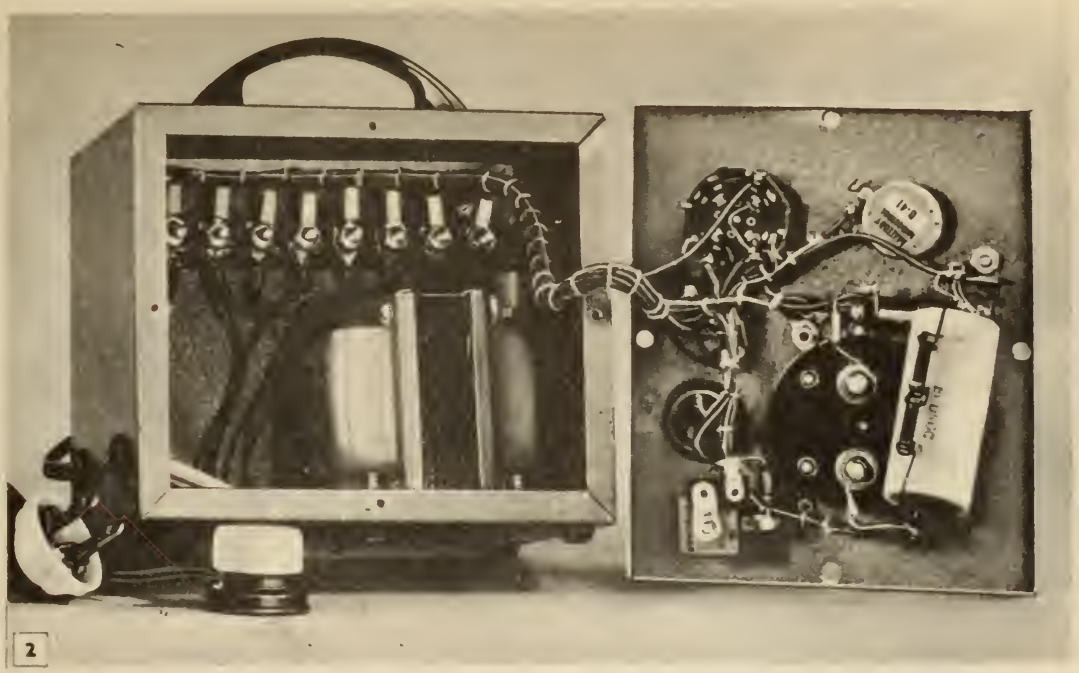
4

5

NEGATIVE-CONTRAST RATIOS

LOW READING *	PAPER NUMBER	EXPOSURE (SECONDS)	CONTRAST RATIO	CONTRAST RATING
2.5	1	8	16:1	VERY HIGH
5	2	12	8:1	HIGH
10	2	8	4:1	NORMAL
20	3	9	2:1	LOW
30	4	8	1.33:1	VERY LOW

* With potentiometer dial set for microammeter reading of 40 when taking all low readings.



All parts are mounted on front panel of utility cabinet except transformer and terminal strip, which are bolted to the bottom and back respectively. Four metal screws secure the front panel to the cabinet

3. Then, move the photocell to the darkest area (highlights) of the projected image and take a reading for that area to determine the contrast ratio between the lightest and darkest areas: e.g., a "lightest" reading of 40 and "darkest" reading of 10 would result in a contrast ratio of 4:1 and a contrast rating of "normal."

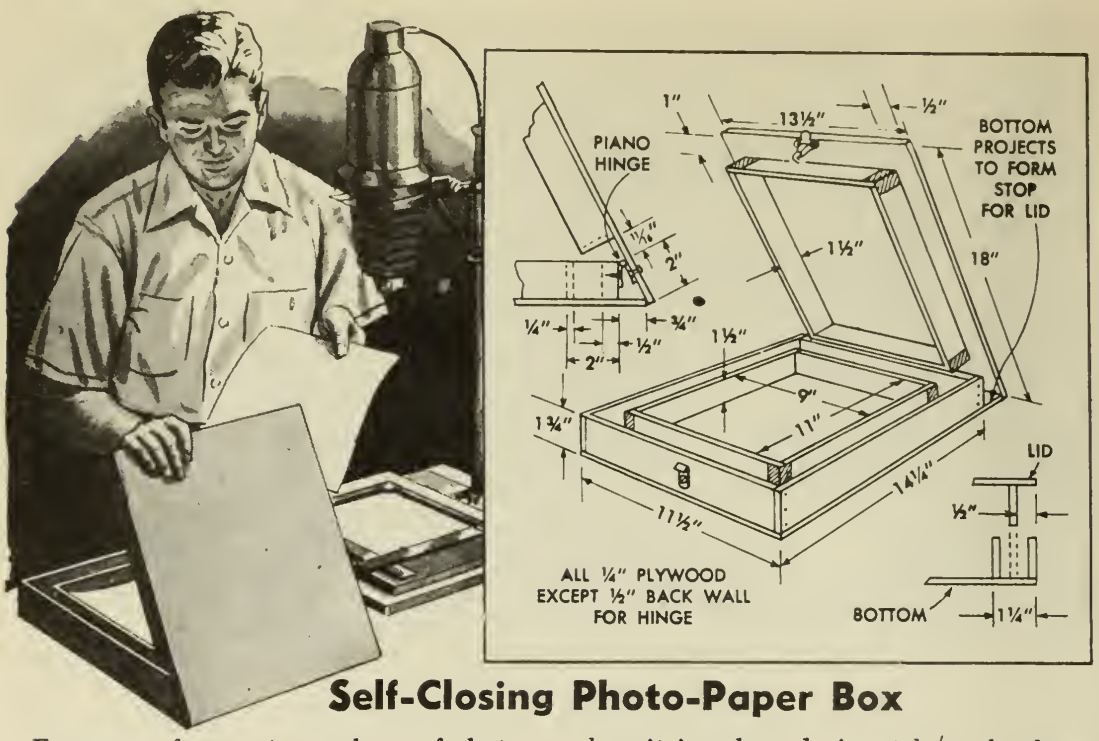
4. After checking the negative-contrast table, Fig. 5, for the recommended contrast number of enlarging paper to be used, test strips are made to determine the exposure time required to produce a good print. It is necessary to follow all of these steps exactly as outlined for the first negative processed in each of the five contrast ratings. When processing subsequent negatives, it is necessary only to determine the contrast ratio, as in steps 1, 2 and 3, and provide an aperture setting that will give a microammeter reading of 40 when the photocell is placed in the lightest area of the negative. The same type of paper, same developer and development time must be used for processing negatives as were used for establishing the negative-contrast ratios and accompanying exposure times. Also, the same procedure applies when determining a table of ratios for processing color negatives, except that only one contrast number of printing or enlarging paper will be listed.

Building the Densitometer

Layout and construction of the densitometer are shown in Figs. 2 and 3. To prevent cluttering of the cabinet-layout diagram, Fig. 3, only the most important dimensions are given. All components are mounted and wired as shown in Figs. 2, 3 and 4, using the parts and materials recommended in the materials list on the opposite page. *Caution:* Observe proper polarity of rectifiers when wiring them.

The photocell body is made from an a.c. attachment plug by disassembling the plug and drilling a ½-in. hole in the center to accommodate the cell. Then, the cell wires are pushed through the bottom slots in the plug and a ¼-in. hole drilled in the side of the plug near the bottom to admit the photocell cord. After the cell wires are joined to the cord, cold plaster is poured around the cell, being careful not to touch the leads, which might cause current leakage and result in a false reading. Finally, a fiber disk is cemented to the bottom of the plug and the photocell is ready to be connected to the proper leads in the cabinet. A plastic bottle cap can be used to cover the photocell when the unit is not in use, as shown in Fig. 1.

If a terminal strip is not used, hookup wires are run directly to the components. After the wiring is completed, check it against the schematic diagram, Fig. 4, to make sure that no errors in wiring have been made. To insure accurate meter readings, the unit should be used at about the same time each day. If there is considerable fluctuation of the line current, a voltage regulator should be used. ★ ★ ★



Self-Closing Photo-Paper Box

Exposure of an entire package of photographic paper accidentally left open can be avoided if the paper is kept in a self-closing light-tight box, such as the one shown. The hinged lid is designed so that it cannot be raised to a vertical position and left open, but automatically closes when it is released. A catch at the front must be released before the lid can be raised. Triple side walls and flat black paint on the inside surfaces prevent light leakage and reflection. Capacity of the box is 100 sheets of 8 x 10-in. paper.

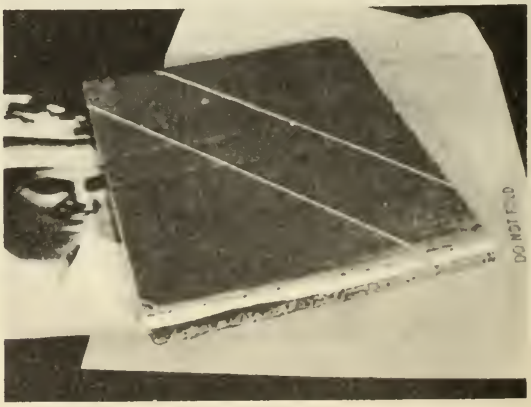
E. R. Haan, Evanston, Ill.

Level Held on Camera Tripod

To level the head of a camera tripod quickly and accurately, fit a pencil-sized level in a bracket slipped over the tripod screw as shown. The bracket is bent from sheet aluminum. To assure that the level is parallel with the tripod top, use a full-size level on the top to align it exactly. Then check it against the small level in the bracket. Adjustments to the small level are made by bending the bracket, into which the level must fit snugly.

Protecting Mailed Photographs

When sending photographs by mail, protect them against damage by sandwiching them between two pieces of stiff cardboard that are held together by a rubber band slipped over diagonally opposite corners, as indicated. Cementing or taping together the edges of the protective sheets is not only unnecessary, but causes added work and inconvenience for the receiver of the photos. On the other hand, the rubber band simply is slipped off the cardboard.



"Sync" Motor Drives
PHOTO TIMER

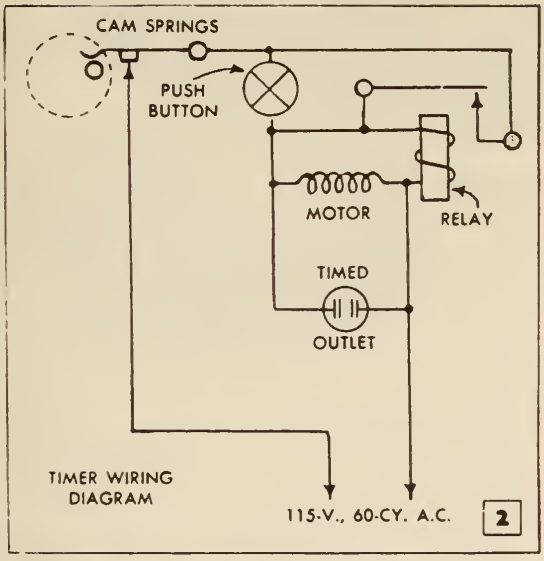
HERE IS A photoprint timer that will automatically time an enlargement exposure to a fraction of a second, and do it with consistent accuracy. This timer differs from most home-built ones in that it uses a synchronous motor rather than a vacuum tube to time the exposure interval. Conditions which affect the normal operation of a vacuum-tube timer, such as varying line voltage and fluctuating operating temperatures, do not affect the sync timer since the motor speed (determined by the current-supply frequency) controls the timing interval.

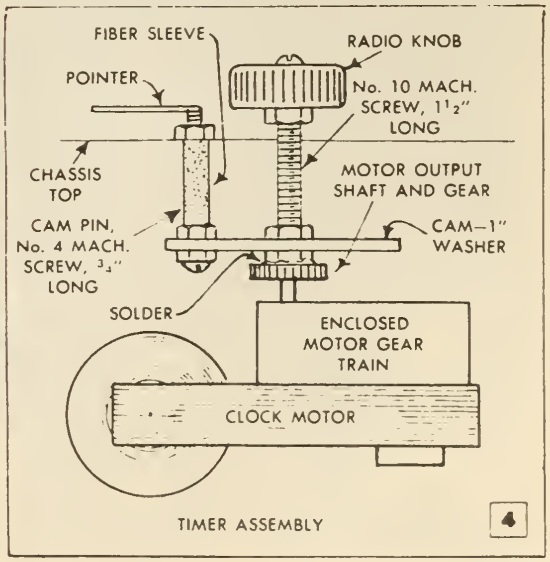
The timer illustrated requires but two main components: a synchronous motor and an a.c. relay. The motor shown was taken from an old electric clock. The motor should have a speed of one to four r.p.m.

Construction Details

First assemble the cam, cam pin and control knob components as shown in Figs. 3 and 4. Then tin the motor output shaft and cam unit and "sweat" them together. After selecting a suitable radio chassis to house your timer, fasten the motor and cam assembly to it.

The relay used in the timer is a Guardian "200" series d.p.d.t. 115-v. a.c. coil. Remove the spring pile-up from the relay and relocate one assembly in the center of the relay. Remaining spring contact and insulator unit is used for cam-spring contact.

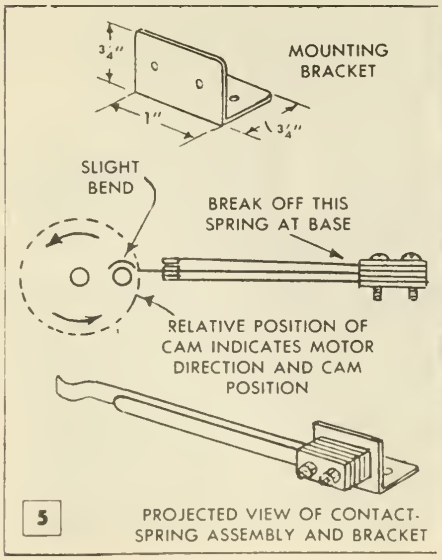




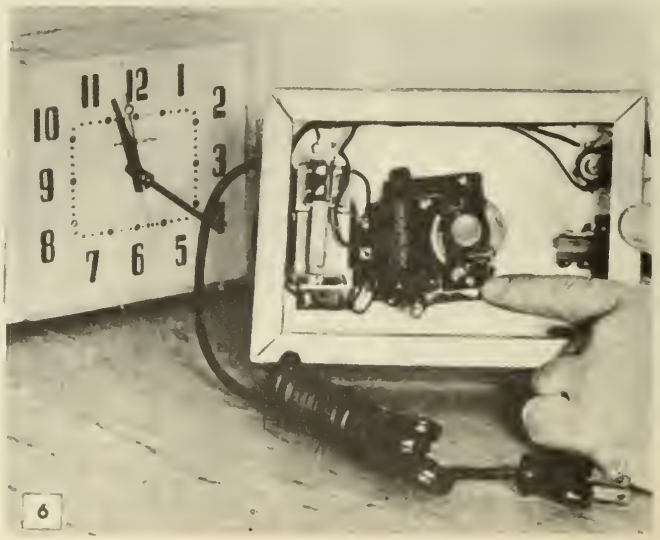
When installing the contact-spring assembly, Fig. 5, mount it on the chassis so that the longer contact spring does not extend beyond the center of the cam pin. After wiring the timer as shown in Fig. 2, it is ready to calibrate.

Calibrating the Timer

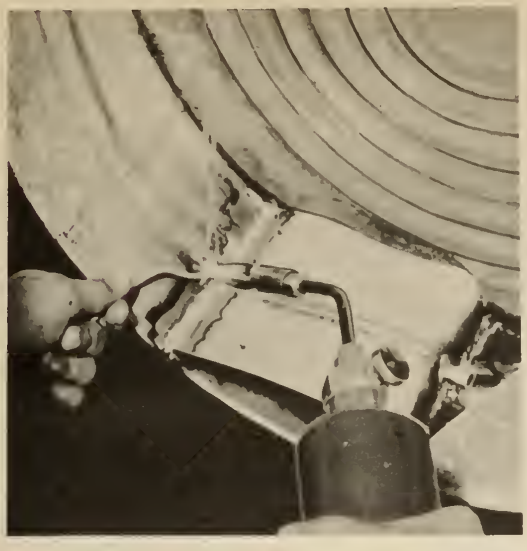
To calibrate the timer, plug an electric clock into the timed outlet of the timer and note the interval involved at the various positions you select by turning the knob. Mark and number these positions on the chassis as shown in Fig. 1. Cam contacts are open when the pointer is at zero. When the cam is rotated (for selection of a time interval) the contacts close, preparing the circuit for operation. Depressing the push button activates the relay which then "locks" through its own contacts and the cam-spring contacts. When the motor returns the cam to normal position and reopens the cam springs, the time interval ends and the unit is ready to start a new cycle. After calibrating the timer, recheck all the wiring, making sure that there are no bare wires in contact with the chassis.



5 PROJECTED VIEW OF CONTACT-SPRING ASSEMBLY AND BRACKET



6

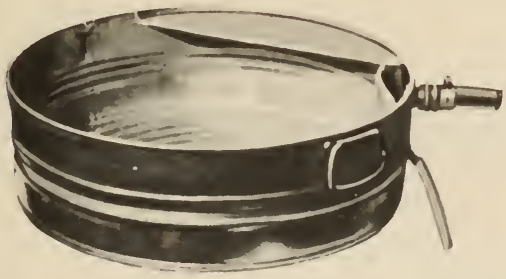


Start with a galvanized pan—a service-station drain pan is just right—and drill holes in side for outlet fitting and inlet tube. Cut and bend sheet-metal outlet baffle and solder to pan as above

Insert copper inlet tube through holes in side of pan and baffle and remove zinc from galvanized surfaces with muriatic acid before soldering. Drill and punch out hole near pan rim for outlet fitting

YOU CAN MAKE THIS

PRINT WASHER



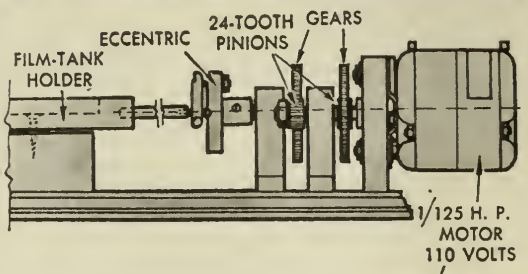
Outlet fitting is standard garden-hose connection having pipe threads on opposite end. This permits fastening fitting to pan side with double nuts, using rubber washers to prevent leakage around fitting

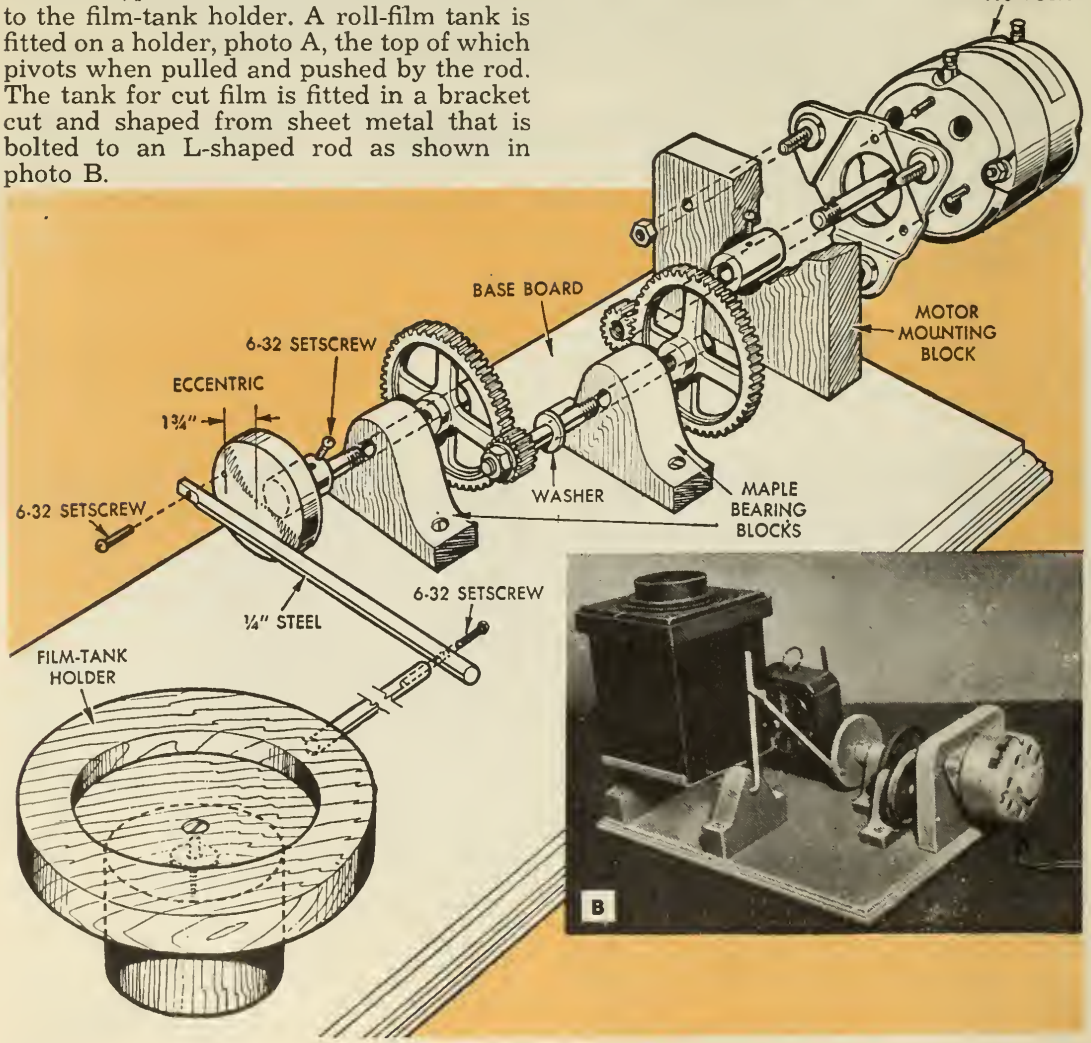
After soldering, clean pan thoroughly and spray with "industrial chrome" finish or aluminum paint. Then waterproof with plastic spray. Print washer may be connected to faucet with portable shower-spray hose

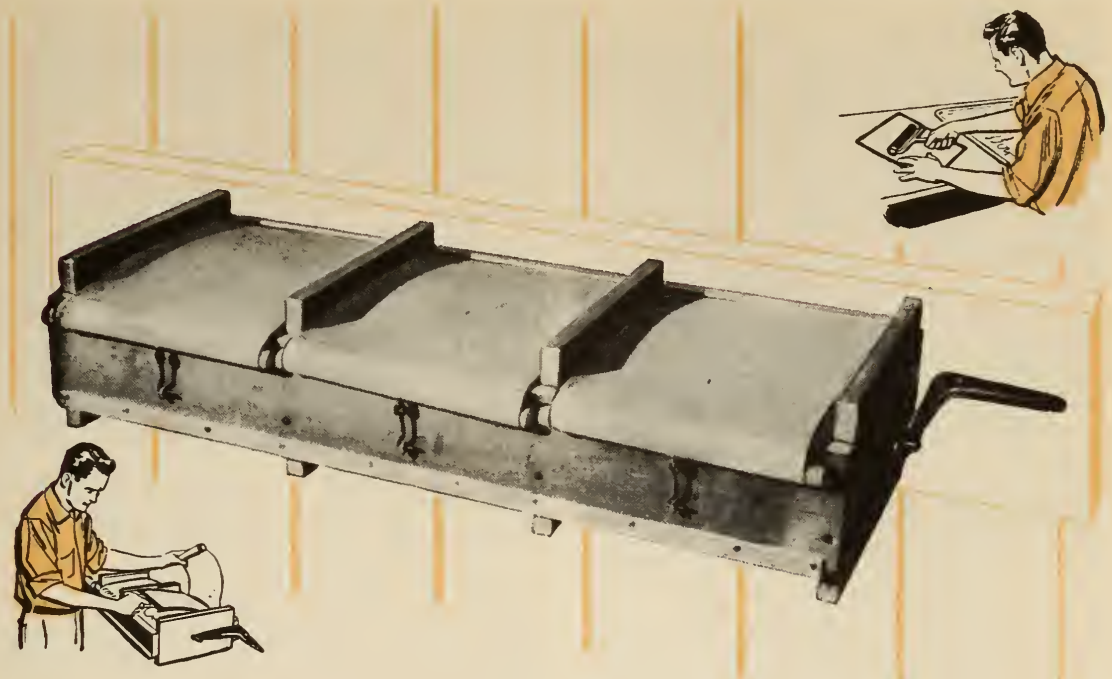
FILM AGITATOR

By L. H. Georger

AGITATION OF FILM tanks during developing no longer need be a manual operation when this powered agitator is used. Power is provided by a 1/125-hp. electric motor that runs at a constant 1550 r.p.m. on 110 volts. These motors are available at hobby shops and some toy stores. Speed reduction is taken care of by two 144-tooth metal gears and two fiber pinion gears purchased at a radio shop. The motor is bolted to a mounting block, as indicated, and the block is screwed to a wooden breadboard or suitable piece of plywood. Maple is used for the bearing blocks in which ¼-in. steel rods rotate as shafting for the gear assemblies. An eccentric, which can be a turned shape, or simply a straight bar, is fitted on the end of the final shaft. A connecting rod cut from ¼-in. rod runs from the eccentric to the film-tank holder. A roll-film tank is fitted on a holder, photo A, the top of which pivots when pulled and pushed by the rod. The tank for cut film is fitted in a bracket cut and shaped from sheet metal that is bolted to an L-shaped rod as shown in photo B.







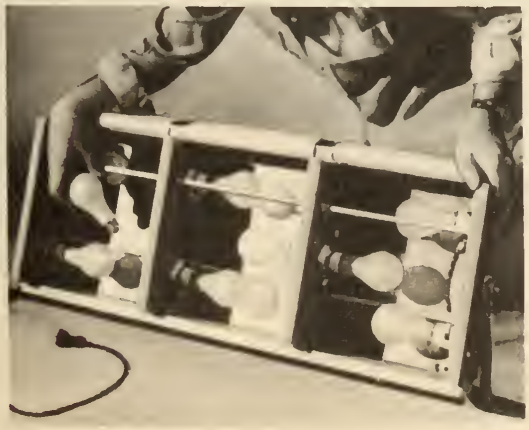
High-Speed Print Drier

UP TO 50 PHOTOPRINTS per hour can be run through this "flop over" drier that is designed to hold standard 10 x 14-in. ferrotype tins. Heat is provided by nine 100-watt lamps held in porcelain sockets as indicated in the lower left-hand photo. A ¼-in. stove bolt is centered in each end of the drier to provide an "axle" on which it rotates. Sockets on the ends must be located accordingly.

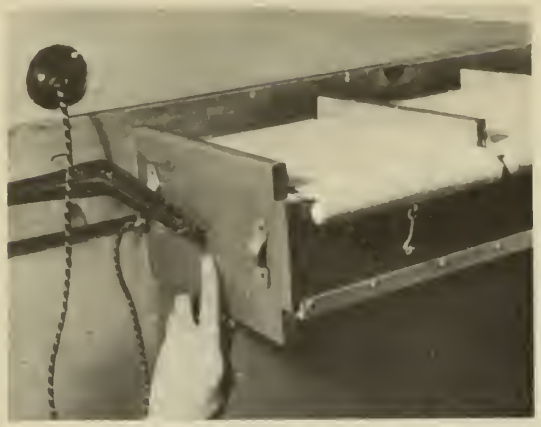
The ends and partitions of the drier are 7½ x 33½-in. pieces of ¾-in. plywood with ⅜-in. holes drilled in opposite corners as shown in the lower right-hand detail on page 1594.

To begin construction, the front and back, which are 4½ x 33½-in. pieces of 1-in. stock, are screwed to one end. Two 36-in. lengths of ⅜-in. dowel are inserted in the holes, and the two partitions and

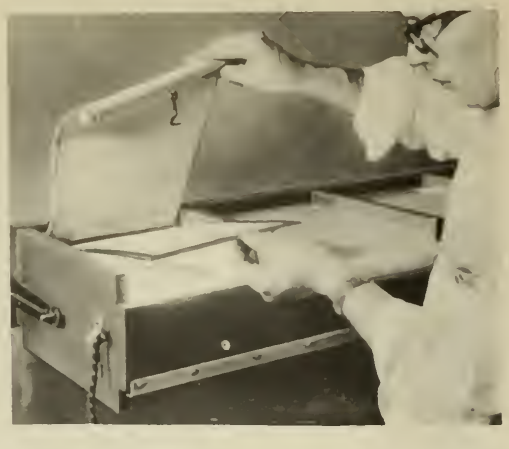
Heat supplied by nine 100-watt lamps fitted in porcelain sockets assures rapid drying of photoprints



Canvas aprons are stretched over ferrotype tins to obtain correct tension, then clamped with angle

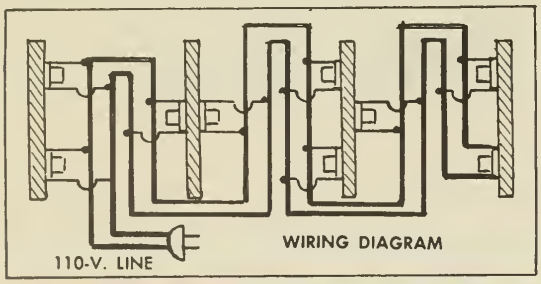


Drier rotates on "axles" consisting of ¼-in. bolts. Axles fit in slotted holes in metal shelf brackets



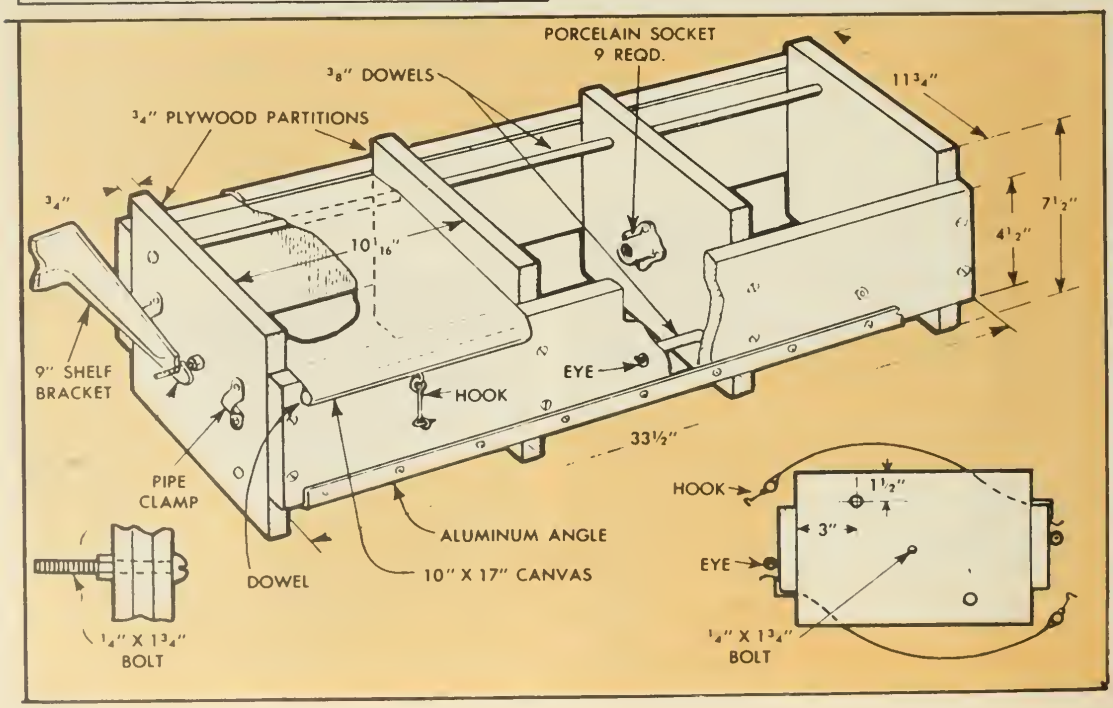
Single-weight 8 x 10s dry in 6 to 8 minutes. Metal or asbestos lining of drier protects wood against heat

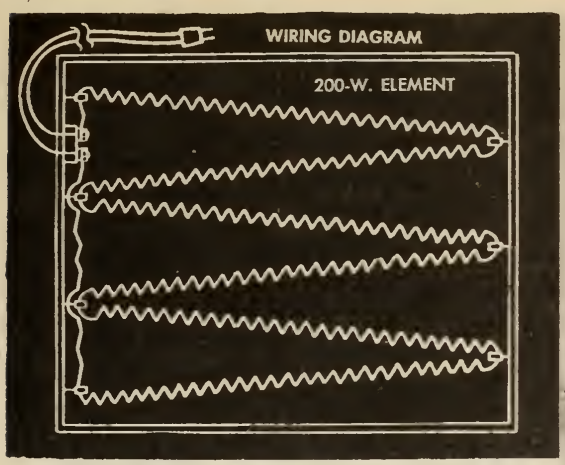
end are fitted on the dowels. Hold a ferrotype tin between the fixed end and the first partition to determine the correct spacing, then screw the partition in place. Repeat this operation with the other partition and end. When finished, cut off the projecting ends of the dowels.



Next, install the 10½ x 17-in. canvas aprons. A wide hem in the bottom of each apron permits inserting a 10-in. length of ¾-in. dowel into which is screwed a screen-door hook that fits in a screw eye driven into the drier frame. Pull each apron over a ferrotype tin in the drier to obtain the correct tension, then tack the end to the frame. When all aprons are in place, screw aluminum angles to the frame for a permanent clamp, as in the lower right-hand photo on page 1593.

Two shelf brackets are used to support the drier on a wall, the screw hole in one arm of each bracket being slotted so the drier can be lifted. Two pipe clamps, each held by a screw, act as stops. ★ ★ ★





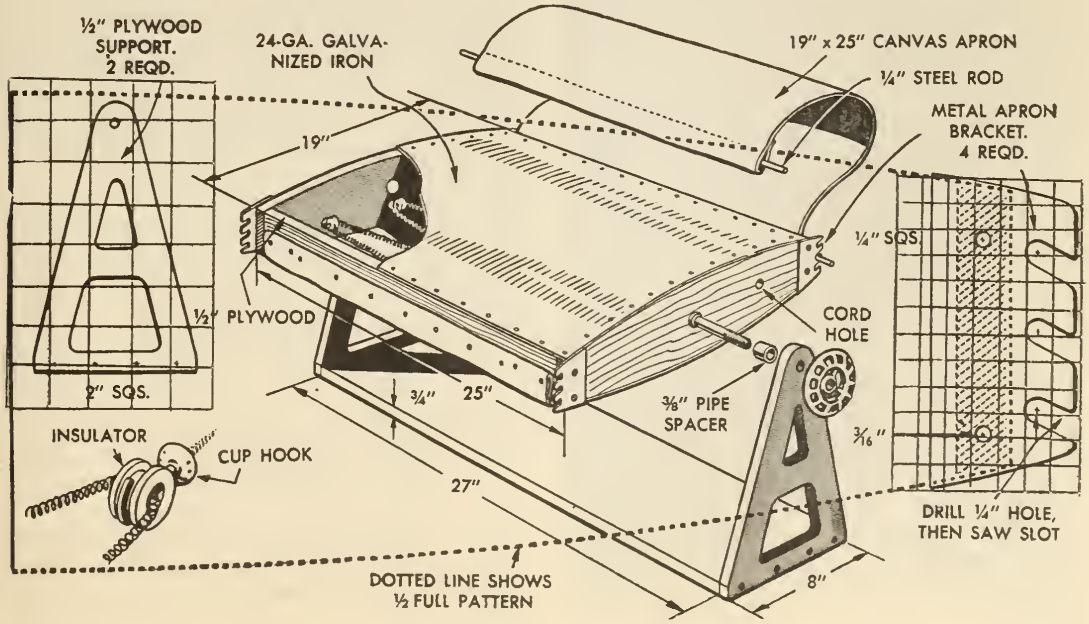
PRINT DRIER

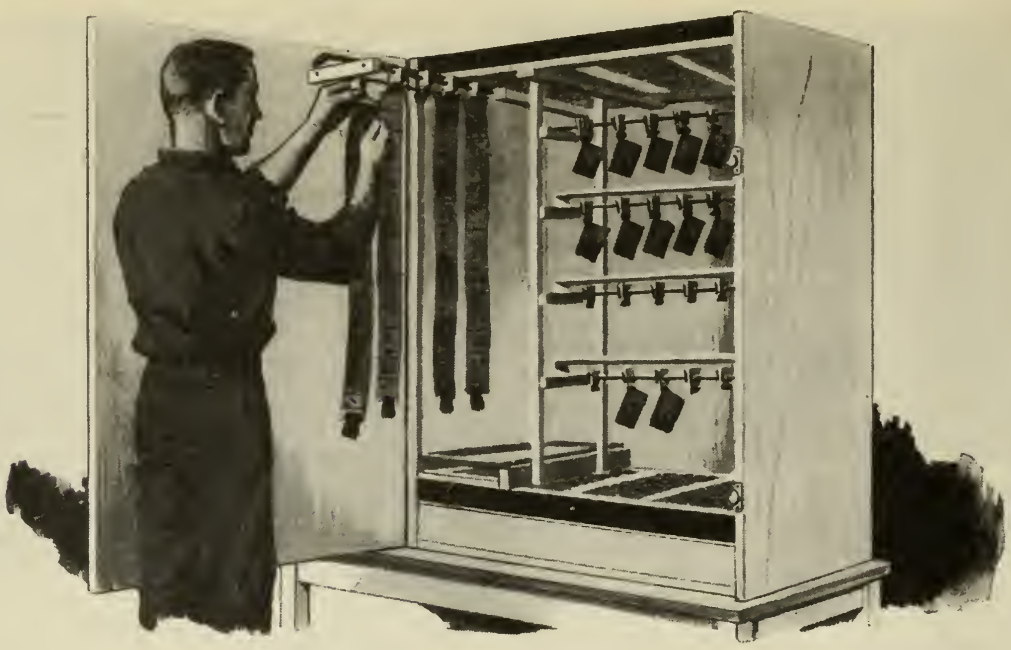
By Jack Wall

DRYING THE PRINTS is the most time-consuming part of printing your own pictures when you have to air-dry them on ferrotype tins. This is particularly true when drying 8 x 10 prints. In this case, an electric print drier is the answer and here's one that will dry eight 8 x 10 prints in about 12 min. The drier is designed to take two standard 18 x 24-in. chrome-finish ferrotype tins, which are loaded in the usual way and then placed in the drier under canvas hold-down aprons.

The heating element is housed in a curved plywood frame that is covered on both sides with sheet metal and which is pivoted between the uprights of a U-shaped stand so the drier can be flipped over for loading both sides. The heating unit consists of three 600-watt toaster replacement elements that are wired in series by joining them end to end and twisting together. When stretched evenly between standoff insulators consisting of cup hooks and porcelain rings, the chrome-nickel wire provides approximately a 200-watt element. The connector between the element and heater cord is from an electric iron.

The pattern for the curved ends of the drier is given in dotted line. This is actually a half pattern which is one-half actual size. Notched metal brackets to which the hold-down aprons are hooked are screwed to the ends of each piece. A valve handle is used as a knob to flip the drier.

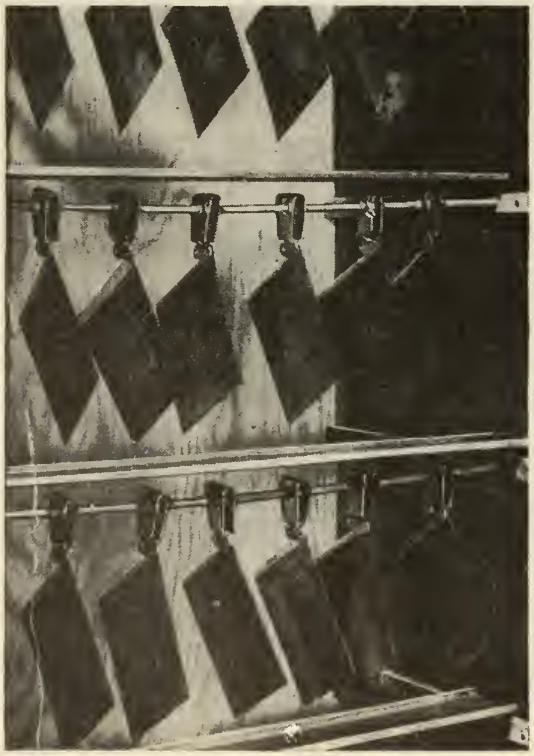




Dry Your Films in Filtered Air

By Hartwell J. Kennard

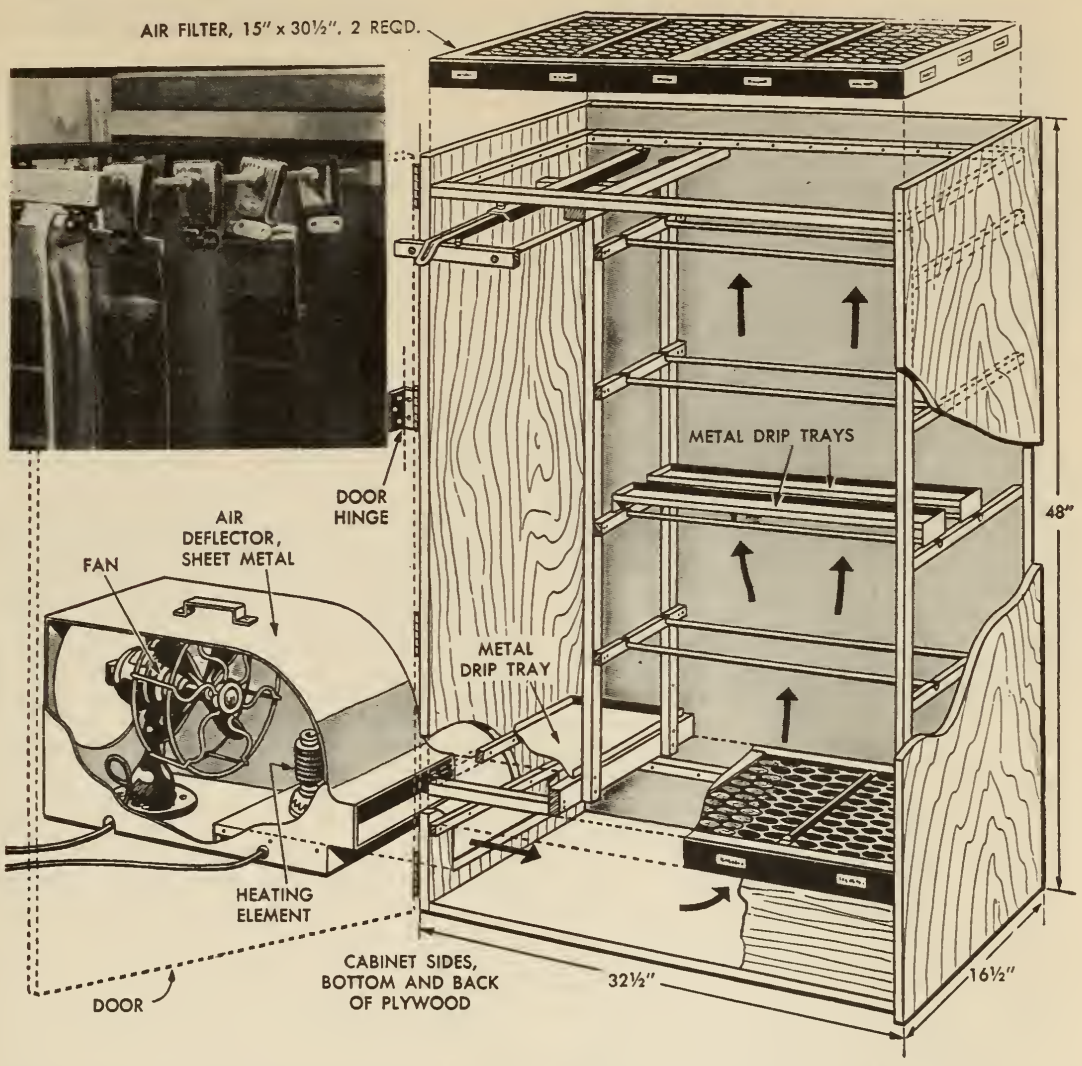
Cut film is hung from dowels by means of film clips which are spaced apart and held with rubber bands



RAPID, UNIFORM DRYING of roll and cut film is possible with this cabinet through which warm air is forced by a fan enclosed in a sheet-metal housing at the base of the cabinet. Air passes over an electric heating element mounted in the fan housing, then through an opening in the side of the cabinet. Inside the cabinet, the air is filtered and moves to the top, drying the film as it rises. The air then escapes through another filter covering the top which is installed to keep dust from settling back into the cabinet. Using filtered air prevents dust from being drawn in through openings or leaks in the cabinet. Too-rapid air current should be avoided as it may pick up loose dust inside the cabinet and deposit it on the film. Periodic wiping of the interior with a damp cloth will minimize this problem.

Dimensions of the cabinet are based on the sizes and quantity of film to be dried. Those given in the illustration on the opposite page are for a cabinet which will accommodate 8 rolls of 120 or 620 film and 64 sheets of 4 x 5-in. cut film at the same time. Height is determined by the length of roll film to be dried while depth and width are based upon intended film capacity and adjusted to a specific size of air filter. Filters used are of the type designed for heating or air-conditioning installations. Insert filters correctly.

Start construction by making a box of ¾-in. plywood to the over-all dimensions of the proposed cabinet. The top is left



open for the exhaust filter, and the door on the front is not installed until the interior is completed. Nail a piece of ¾-in. plywood about 5 in. wide between the sides at the bottom of the door opening to form a warm-air chamber. Then nail ¾-in. square cleats to the sides and back panel, at the same height, on which to rest the lower filter. Cut a slot for warm-air intake in one side of the cabinet just below the cleat. Construct the sheet-metal housing which can be slipped down over a conventional circulating fan to direct the air from it into the slot in the cabinet. Mount one or two heating elements inside the housing in front of the fan to warm the air. A round hole of the same diameter as the fan blade is cut in the back of the housing through which air may be drawn by the fan.

Returning to the cabinet, nail a framework of cleats inside a few inches down from the top to support the exhaust filter. Fasten a cross piece between the front and rear cleats and suspend the vertical supports for the cut-film racks and drip trays as illustrated. Each rack is a length of dowel rod fitted with film clips spaced equally apart by means of rubber bands which are doubled around the rods on both sides of the clips. This system permits changing of the spacing for different sizes of cut film. Cut notches in the horizontal supports at each end of the racks to space the racks properly front to back. Drip trays are made from galvanized sheet metal and placed on the supports below each rack. Cut the ends of the trays extra long so that when they are soldered on they will extend down to form legs. Then the trays will not interfere with the removal of the racks. Since individual racks can be removed for loading, the cabinet door is only open for short periods of time allowing less dust to enter.

A pot-and-pan rack which pulls out for loading is used to hold roll film. Pot hooks are replaced with dowel rods which are fitted with film clips. ★ ★ ★

Cable Release Through Hand Strap Permits Off-Camera Flash

By looping the cable release through the hand strap on a press camera, the camera can be easily held and fired with one hand while shooting in the normal position. This is especially helpful when firing with synchronized flash through the shutter which would otherwise require three hands to hold the camera, press the release and hold the flashgun off camera.

Wayne Floyd. Fayetteville, Tenn.

¶To help make your darkroom lightproof, try attaching a piece of weather stripping to the bottom of the door. Use the kind composed of a metal strip with felt attached. This will shut out any light that might filter in under the door yet at the same time allows for free movement of the door.

CARDBOARD STEREO VIEWER

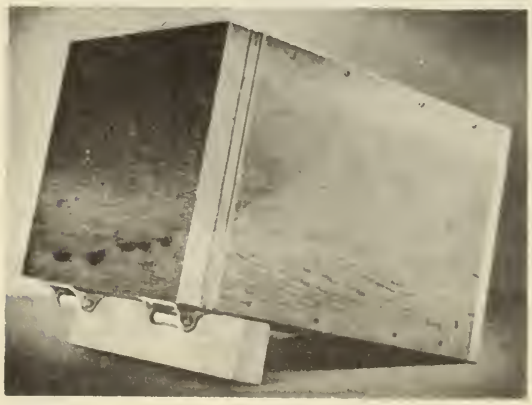
By Allan Carpenter

THE NEXT TIME you entertain a group of friends with stereo slides, it won't be necessary for each person to wait until the viewer is passed to him. All that you need do to eliminate this inconvenience, is make several cardboard viewers like the one shown in the drawings so that at least one viewer is provided for every two people present.

To make a viewer, first outline the various parts in full size on medium-weight cardboard. Draw dotted lines for folds as indicated in each of the drawings. Then, cut the parts from the cardboard stock and make the indicated cutouts in the slide carrier and focus component, detail A, and in the lens housing, detail B. After gluing a strip of household wax paper over two of the square cutouts as shown in detail A, the slide carrier and focus component is folded as indicated by the dotted lines. Cellulose tape is used for joining the edges that form corners. The free end of the slide carrier is then folded inward and glued to the bottom as shown. A cardboard tab for pulling the carrier when focusing a slide, is taped to the bottom at the front to complete this component.

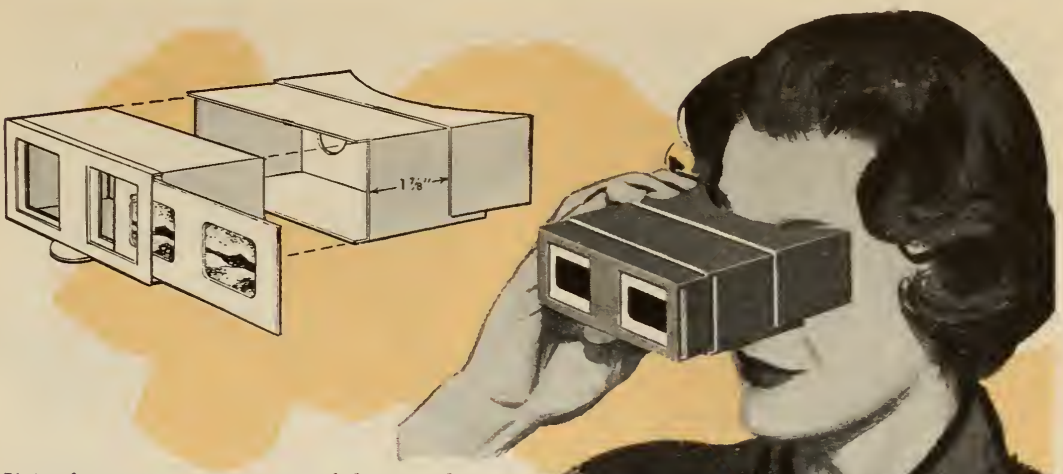
Before folding and taping the edges of the lens housing, the lenses are centered on the ¾-in.-dia. holes and taped in place as indicated in detail B. The diameters of the lenses used is not important except that the lenses be of the same size and focal length for any one viewer and have a diameter of less than 1½ in. but greater than

Handy Darkroom Safe for Enlarging Paper Has Self-Closing Door



This light-tight paper safe was made by one amateur photographer for storing enlarging and print paper. Plywood strips glued in ¼-in. rabbets cut in the inside edges of the door and open end of the box overlap when the cover is closed. All corners of the box are rabbeted to prevent light leaks. The door is mounted on spring-loaded hinges that automatically close it when released. A block of wood supports the front end of the safe so that it is on a slight incline to prevent paper from falling to the floor if other sheets should cling to the one being withdrawn.

B. Brownold, Cedarhurst, N. Y.



⅞ in. for proper positioning of them in the space allotted.

The light shield, detail C, is installed simply by folding the ends along the dotted lines and gluing it to the lens housing as shown in the detail at the top of this page. To improve the appearance of the cardboard viewers and protect them from soil and wear, all outer surfaces are sprayed with paint of the type that is sold in pressurized cans. Be sure to allow sufficient time for the paint to dry before inserting the slide carrier into the lens housing. ★★★

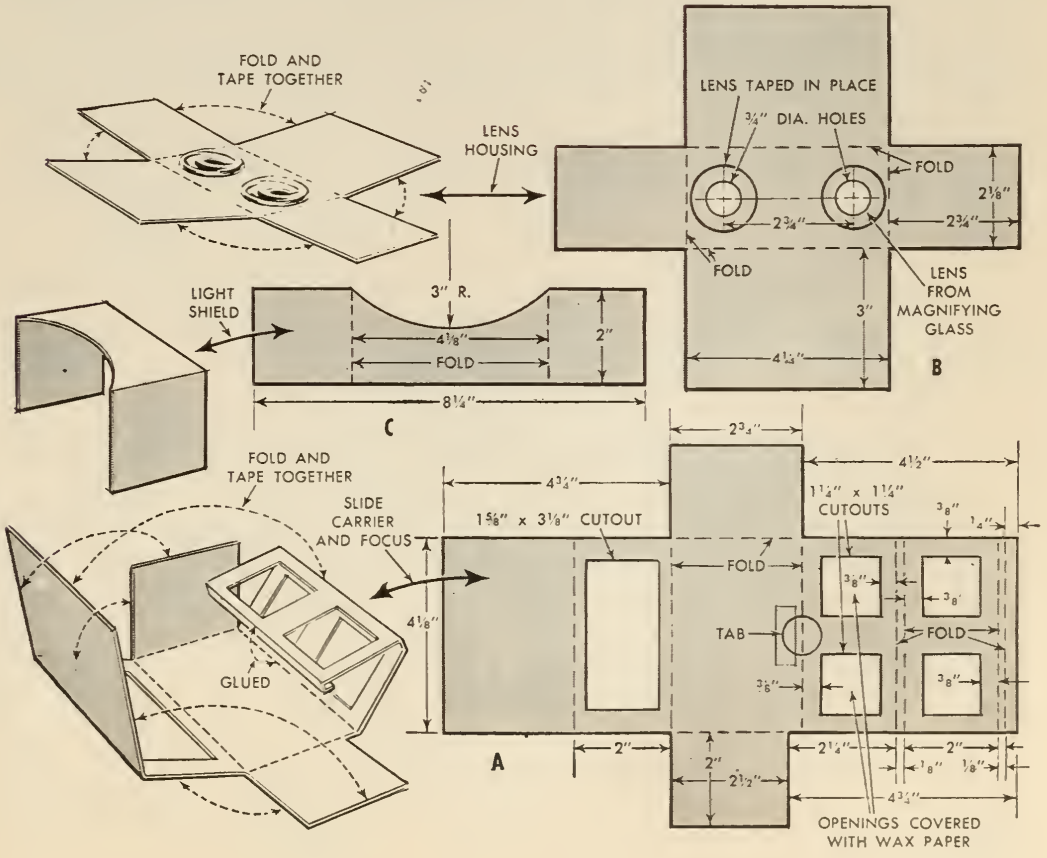
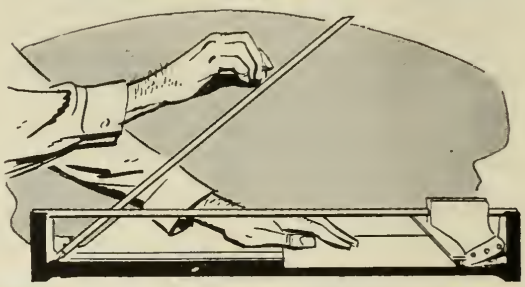
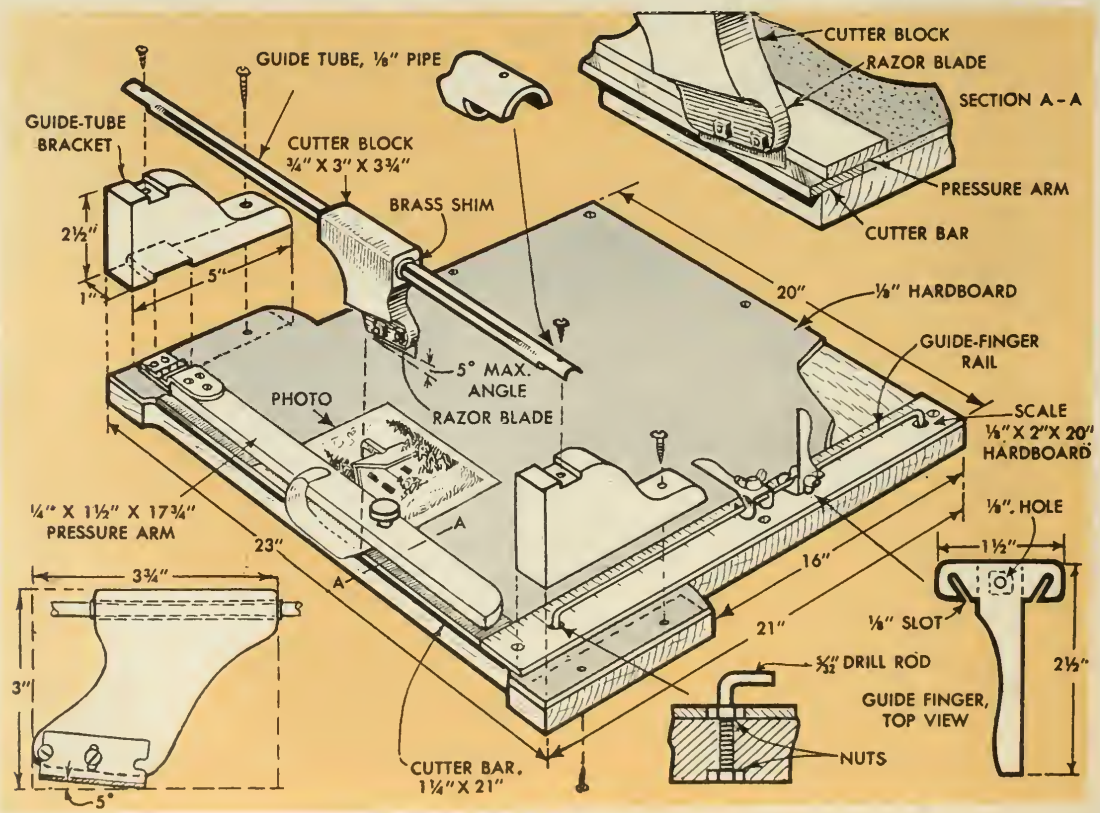


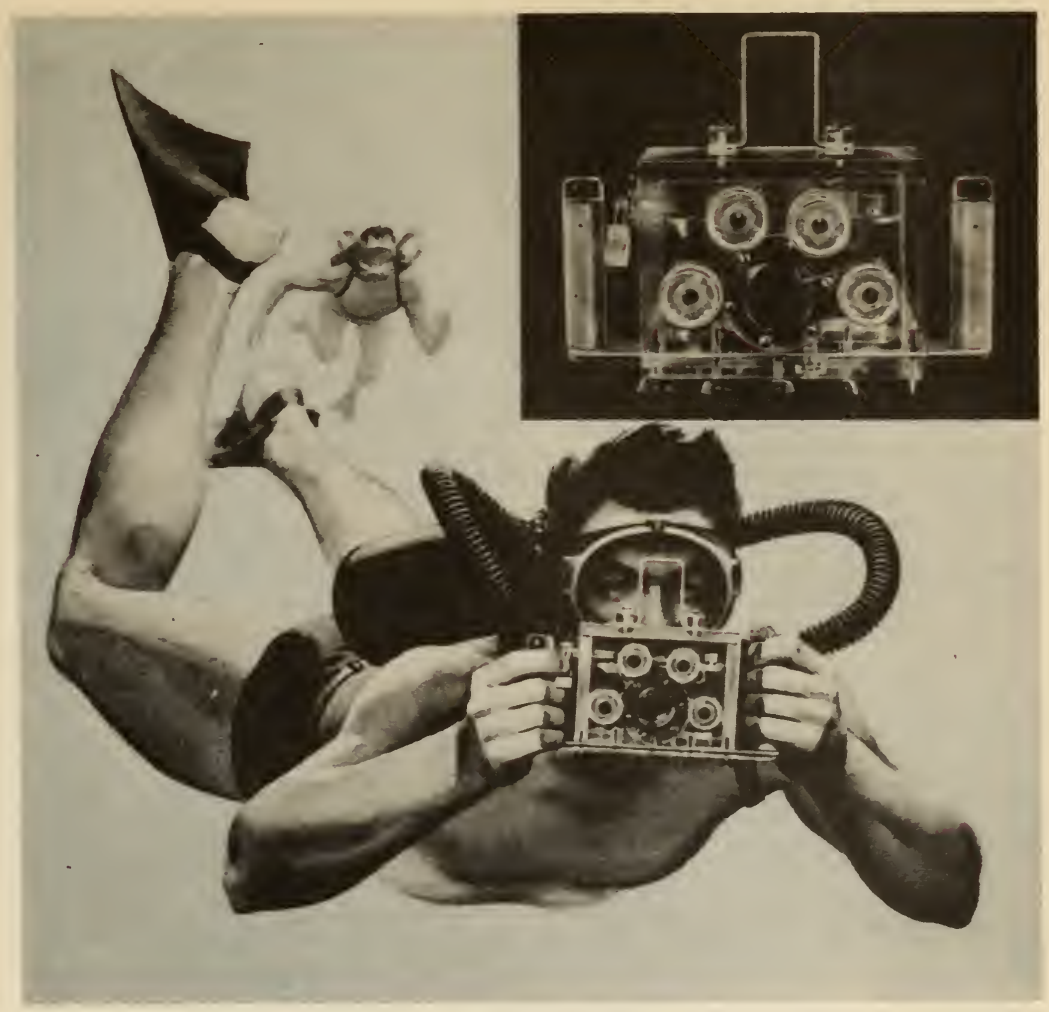
Photo Trimmer

LARGE IN SIZE but small in cost, this cutting board uses a sliding cutting blade in place of the conventional arm.

The base is ¾-in. plywood, cut to the shape shown. Screwed to one edge and allowed to project 1/16 in., a length of ⅛-in. flat steel provides a cutter bar. A sheet of ⅛-in. hardboard covers the rest of the board. White-enameled hardboard with inked numbers is used for a scale and screwed to the board at right angles to the cutter bar. The guide fingers, shaped as in the detail, slide on a rail made of 5/16-in. drill rod. Each guide is held in position with a thumbscrew turned into a nut soldered on the inside of the guide. The rail is threaded at both ends and bolted to the board through the scale. The wooden guide-tube brackets are not notched to receive the brass guide tubes until the cutter block has been mounted and the blade aligned. The cutter block is drilled oversize and the hole lined with brass shim stock to provide a bushing. A single-edge razor blade is mounted on the block with screws so it can be adjusted. The pressure arm is screwed, or riveted, to a Z-shaped strip of brass which is soldered to a butt hinge. The hinge, in turn, is screwed to the base.







Plastic case designed for Mercury II camera can be used with other cameras when controls are relocated

TAKE YOUR CAMERA UNDERWATER

By Hampden Banks, Jr.

WITH YOUR 35-mm. camera in this watertight plastic case you can photograph marine life in black-and-white or color just as easily as taking pictures on land. The case described in this article is designed for a Mercury II camera, because this model enables one to take 72 split-frame pictures on a 36-exposure roll without disassembling the case to reload. However, almost any 35-mm. camera can be used simply by relocating the controls.

When making the case, first cut the sides, ends, top and bottom from ½-in. plastic and machine to size, leaving the protective paper on the material to prevent scarring its surface. After grooving the inner surfaces of the ends as shown in Figs. 1 and 2, for positioning the camera, the sides, ends and top are cemented together. When cementing two pieces of plastic, the interfaces need not be polished. It is sufficient to sand the machined edges only with No. 400 grit sandpaper. If clamps are used, they should be pulled up not too tightly, to permit the cement to spread evenly. When applying cement, use an eye dropper. A well-cemented joint is completely transparent.

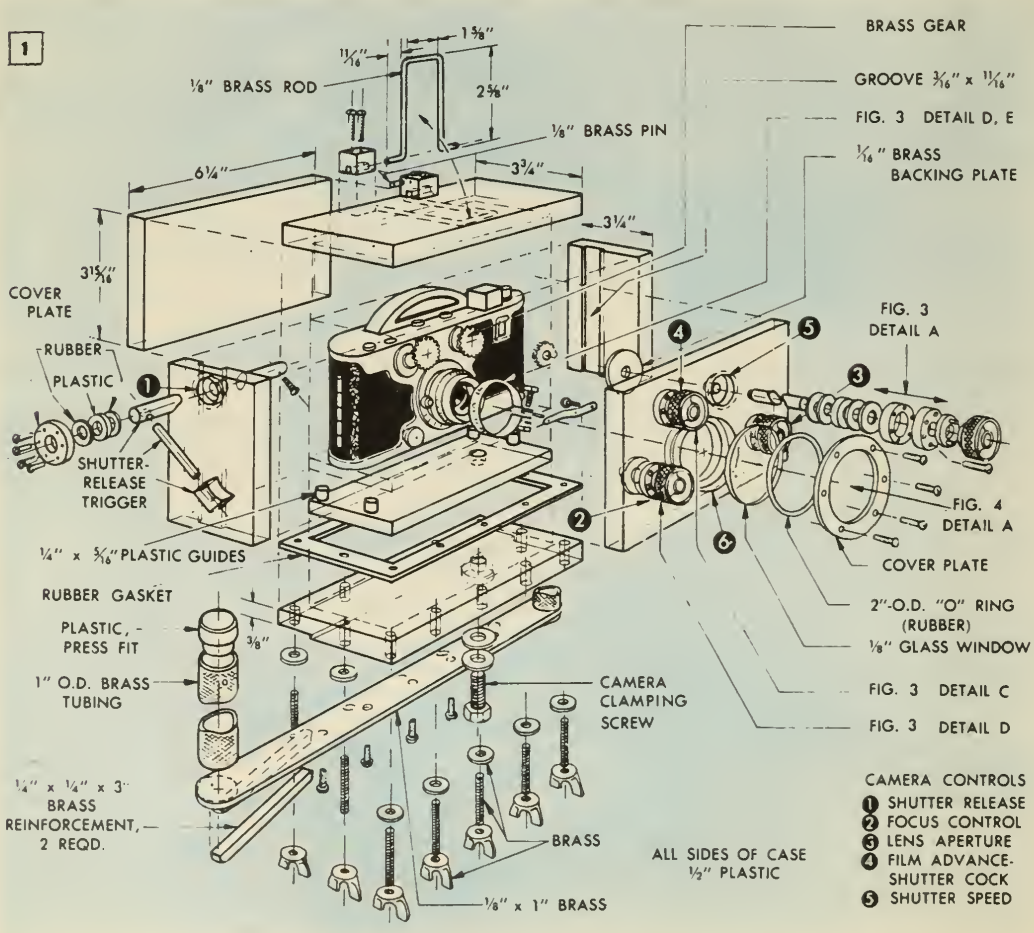
Next, a rectangle is cut from ¼-in. plastic to fit snugly inside the bottom of the case. This piece, when cemented to the bottom member of the case, serves as a base plate for the camera and provides for proper

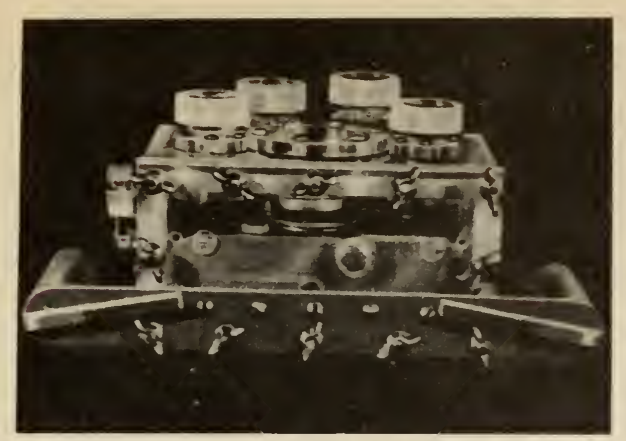
positioning and clearance for the camera controls. After drilling the bolt hole in the base assembly, it is counterbored 3/16 in. deep to accept two rubber gaskets and the head of the camera-clamping screw, after which the camera is bolted in place. Four 1/4 x 5/16-in. plastic guides are then cemented to the base plate as shown in Fig. 1, to aid in positioning the camera each time it is placed in the case.

Assemblies for Camera Controls

The brass fittings for the film-advance, shutter-cock and shutter-speed controls are cut and machined from brass tubing and rod as required and the gears silver-soldered to them as shown in Fig. 4, detail C. The brass collar for the film advance is machined to provide a press fit directly on the camera knob, while the shutter-speed control merely replaces the original knob on the camera.

When making the metal collar for the aperture control, Fig. 3, detail E, the *f*-numbers and calibrations should be reproduced on a strip of paper and glued on the collar after the latter is positioned properly over the lens barrel with the pin and offset control rod attached. Then, the small knob on the camera body used for focusing is tapped and a control rod, the same as the one used for the aperture control, screwed to it. Next, control-knob holes are machined in the front and one end of the case as shown in Fig. 4, detail B, and all plastic control-knob fittings are machined and polished. When drilling, tapping, milling or turning plastic, use liberal amounts of kerosene for lubricating it. After the rubber gaskets are cut from a piece of inner tube about 1/16 in. thick, holes for fastening the cover plates are tapped, and parts for the controls made as shown in Figs. 2 and 3, after which each control is assembled and inserted in its respective hole in the case. When the inside assemblies are completed as shown in the details, each is secured to the shaft cut for it, Fig. 4, detail D. Also, the focus and lens-aperture controls are connected to





When inserting camera in case, be sure trigger-release screw is out of way and gears mesh, then secure base with wing nuts

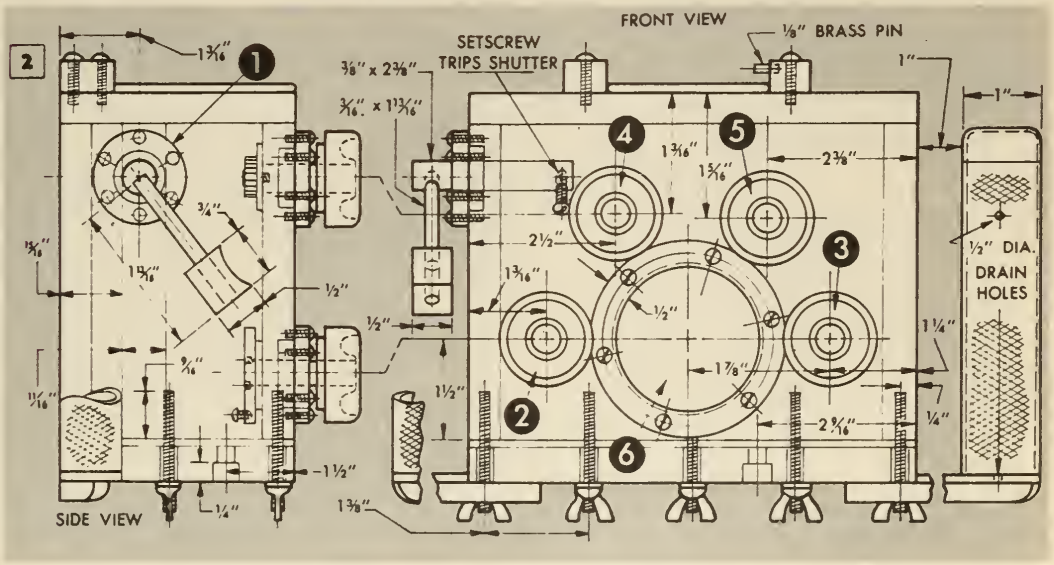
their respective controls on the camera and checked for proper alignment at this time. The outside assemblies are the same for all controls except that a trigger-release arm is used in place of a knob on control No. 1. Only one rubber gasket is required on each side of the plastic disk for controls 1, 2, 3 and 4, and the plastic chamber extension is needed on the shutter-speed control only. This is necessary to permit the gears on the latter to be disengaged for unobstructed action of the shutter-gear train.

When satisfied that all controls work smoothly, cement the plastic disk in position on each shaft so the rubber gaskets fit flush in their chamber after the gaskets are coated with silicone grease and secured by the cover plate. All parts for the controls are made from plastic stock except the gaskets, control rods, aperture-control collar and gear parts.

Lens-Cover Plate

For a watertight installation of the lens-cover plate, machine the aperture accurately to the specifications shown in Fig. 4, detail A, and screw the parts into position. The "0" ring needs no silicone grease. It is wise to keep this grease away from parts to be cemented since presence of the material will prevent a bond between surfaces.

To accommodate the ⅛ x 1 x 10 7/16-in. length of flat brass to which the reinforcement bars and handles are silver-soldered, the camera is removed from the base plate and a rabbet is cut in the bottom member,



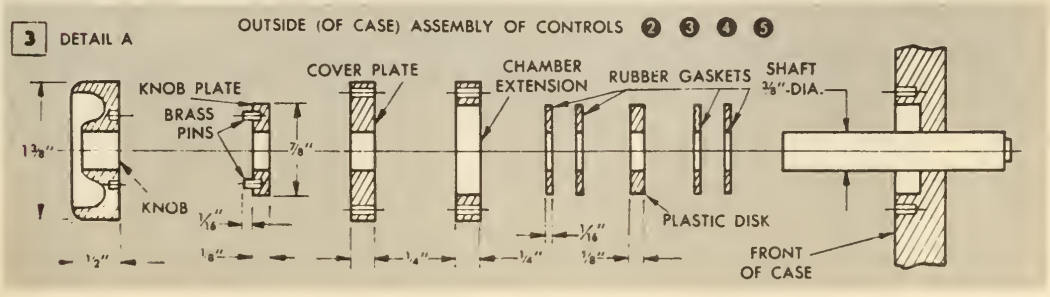
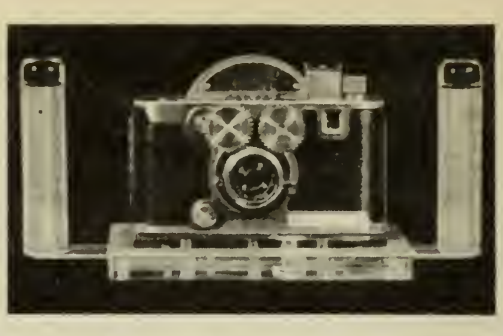
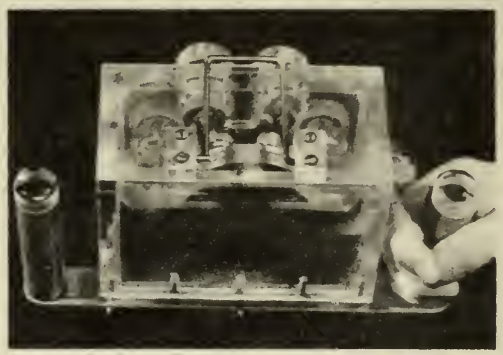


Fig. 1. The handle assembly is then screwed to the bottom and holes for securing the latter to the case are drilled, spaced 1⅜ in. on center as shown in Figs. 1 and 2. The holes drilled in the vertical members of the case are tapped to receive 1½-in. studs cut from 8-32-threaded brass rod. The studs are then coated with cement and screwed in position. A rubber gasket cut from an inner tube and coated with silicone grease on both sides provides a watertight seal when the bottom is screwed in place. When fastening the bottom, only moderate pressure should be applied on the wing nuts, tightening those at the center first and working outward. The grease on the gasket will appear to change color when a watertight seal is made. If the case is not to be used for a time, the cover-plate screws should be loosened to prevent slow seepage of the grease out of the fittings.

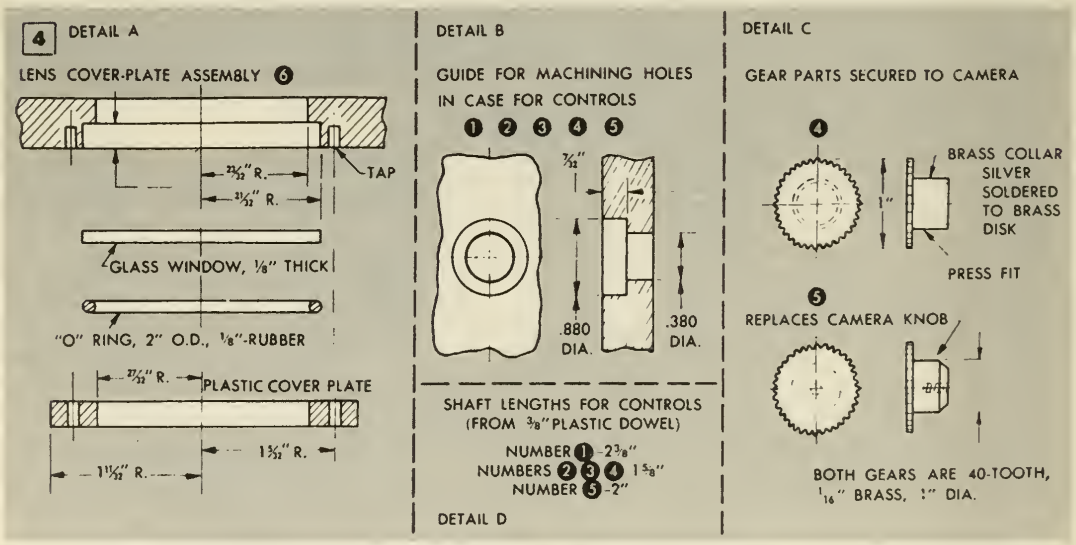
The design of the plastic case provides for a slight buoyancy for easier operation of the camera. If no buoyancy is desired, the hollow handles may be filled with small pieces of brass, copper or stainless steel. ★ ★ ★

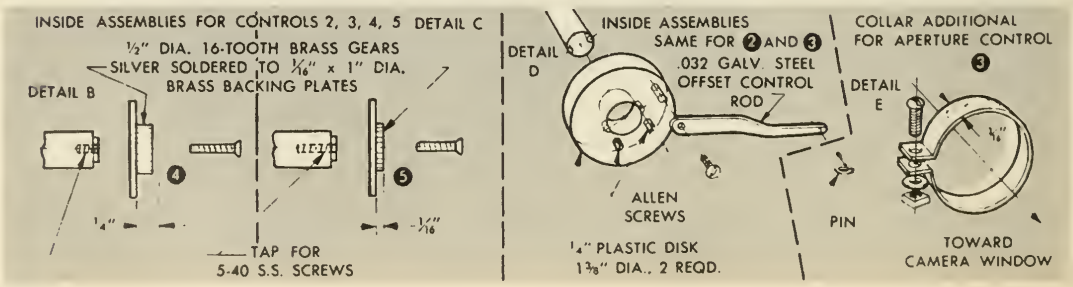


Above, after brass gears are silver-soldered to appropriate fittings for film advance and speed controls, the latter two are installed in place of knobs

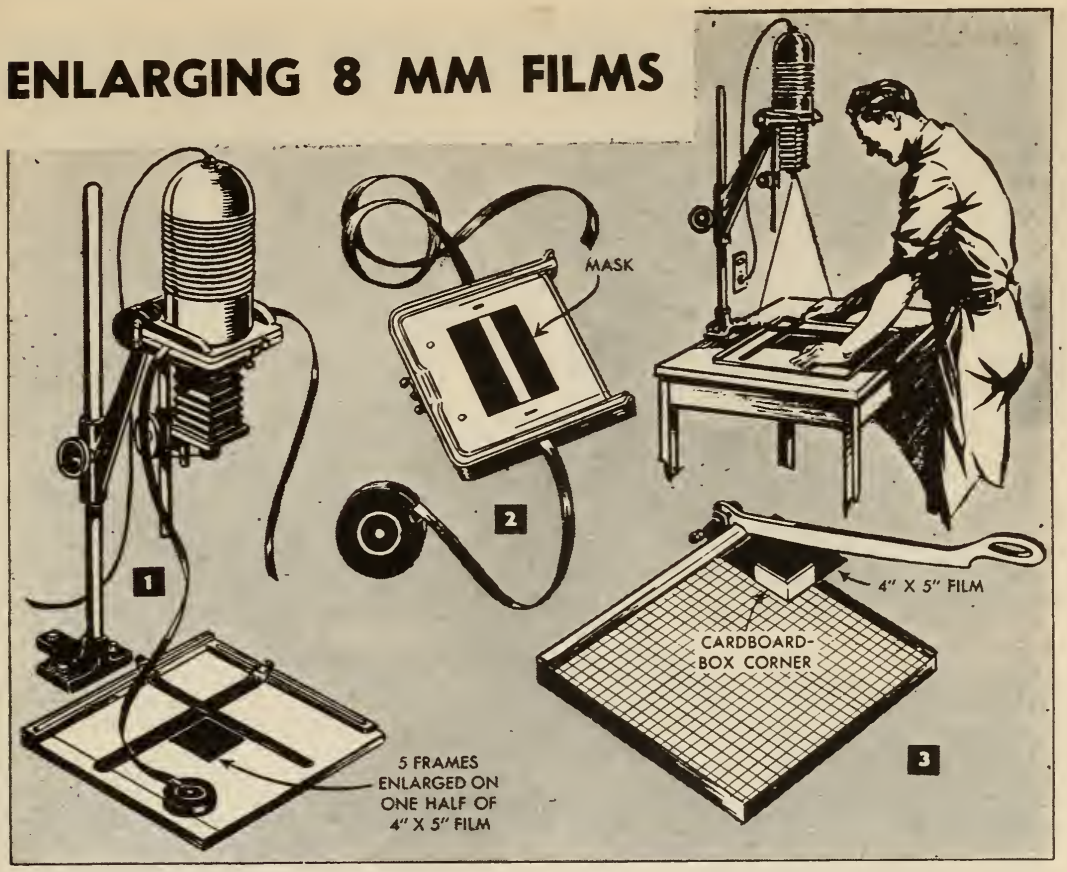


Right, view finder mounted on ⅝ x ⅞-in. plastic screwed to top of case folds flat when not in use





ENLARGING 8 MM FILMS



All that's needed to make enlargements from 8mm. movie film is an enlarger, some 4 by 5-in. cut film and a fine-grain developer. The procedure is much the same as when making any enlargement except that the movie-film positive is projected on regular film first to produce the negative from which the final print is made. The film for the negative should be a fine-grained panchromatic type.

First step, of course, is selection of the scenes from the movies that you wish to enlarge. Because the picture will be magnified many times, the frames should be those which are in sharpest focus. Place the film strip in the negative carrier of the enlarger so that at least five frames of the scene can be projected at the same time, and be sure to mask the strip carefully, Fig. 2. If the enlarger has a glassless carrier, place one edge of the strip so that its entire length is held between the carrier plates to prevent possible buckling. Then, as before, mask off the rest of the opening. Let the loose ends of the film hang down out of the way, Fig. 1.

In the darkroom, cut the 4 by 5-in. film lengthwise so there are two strips, each 2 by 5 in. If a cardboard-box corner is used to position the film on the trimmer, Fig. 3, the task will be much easier and the results will be accurate. To project the movie film, place the carrier in the enlarger and focus on the easel so that each frame is about 1 in. wide. Then place the cut film on the easel and project the 8mm. frames on it. Five frames should about cover the length of the strip.

With five frames on the same film, it's possible to give each one a different exposure, much in the same way that a test strip is made on enlarging paper. At first it will be necessary to do a little experimenting; for example, try exposures of 1 sec., 2 sec., 4 sec., 8 sec. and 16 sec. with the lens set at f:11. However, the exposure will depend somewhat upon the light source in the enlarger and the speed of the film being exposed. Once the approximate exposure range necessary for the materials and equipment you have has been determined, the 5-test strip should cover scenes from most films.

The negatives that are made will be about the same size as 35mm. film. As mentioned, use fine-grain developer and avoid too much contrast. Then select the best frame and enlarge it as you would any other negative, using a matte-finish or similar paper to avoid grain.

HOW TO PROCESS SHEET FILM

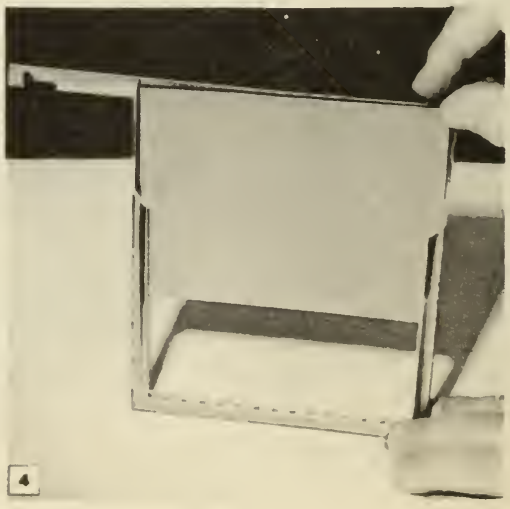
For the advanced amateur photographer considering purchase of a professional-type "press" camera, here is a method of processing sheet film that will help to produce good negatives

Fig. 1. Before unloading exposed film, organize work area in darkroom. Stack film holders at center of table, place film hangers on pegs with retainers flipped open, be sure developing solution is at 68 deg. F.

Fig. 2. Before turning off lights, turn locking pins on holders to center position so slides can be readily withdrawn in dark. Room must be totally dark from now until film is removed from hypo

Fig. 3. When removing film, anchor holder to table by pressing along bottom edge with right hand. Draw out slide about 2 in. with left hand and remove film, being careful not to touch emulsion with fingers

Fig. 4. Hold film hanger upright with left hand, slide film into channels and close loading flap. If film doesn't fit loosely in guide channels, open flap and remove and reinsert film properly



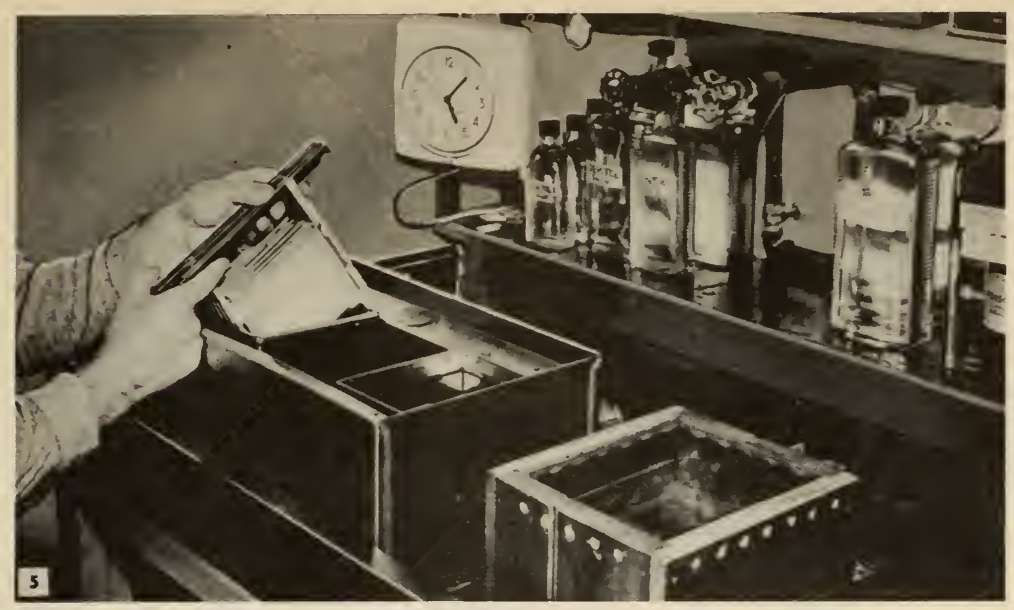


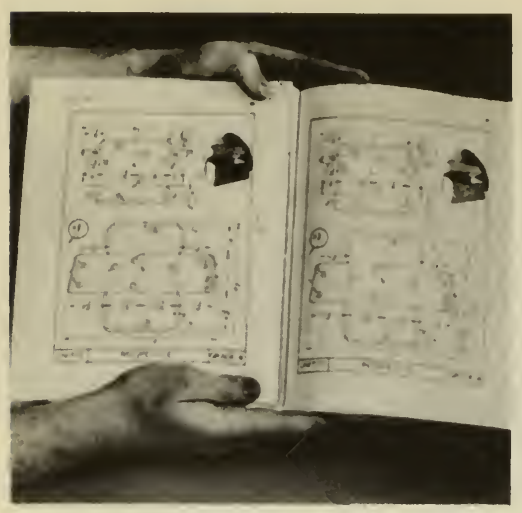
Fig. 5. Place loaded film hanger in empty tank. Repeat with successive hangers, using hand as spacer to prevent scratching film. Later, transfer entire group to developing tank at once. If fast-acting developer (3 to 5 min.) is used, stay with films until timer rings, immerse them in water 2 min., hardener-hypo bath 10 min., and water wash 30 min.

Fig. 6. Daylight tank permits processing sheet film outside of darkroom. After loading grooved reel with exposed film in total darkness, place reel in tank, secure lid, fill with developer and agitate with rod

Fig. 7. Before loading film, insert slides ½ in. into holder. In darkroom open bottom flap and slide film in guides with notches in upper-right corner, emulsion side up. Fig. 8, after film is inserted, press end flap down and push slide in until flap is engaged. Then turn locking pin to closed position to prevent slide from being pulled out of flap accidentally

COPYING WITHOUT A CAMERA

By Rolfe F. Schell

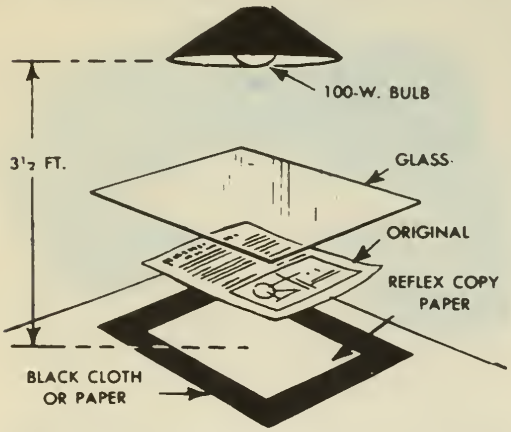


Note that copy at left is more contrasty than original at right. Lines and details are much sharper

REFLEX paper makes it possible for anyone to copy an illustration, diagram or other drawing photographically without a camera, and directly from a book or magazine without mutilating the printed page. It can be done in a darkened kitchen or bathroom, and the chances are you already have the few items of equipment necessary.

Reflex copy paper is a sensitized paper which can be exposed only when the light source comes from the emulsion side. Light directed through the paper from the back side has no effect upon the emulsion. Only when the light reflects from the white of the prototype and back to the emulsion is the paper exposed. Reflex copy paper is available from photo and office-supply stores in sheets 8 x 10½-in. size and costs but a few cents per sheet. It must be handled in total darkness except during development which can be done in subdued yellow-green light.

As for equipment, you will need a piece of black paper or cloth, a sheet of clear glass, a 100-watt bulb and glass baking dishes to serve as developing trays. The



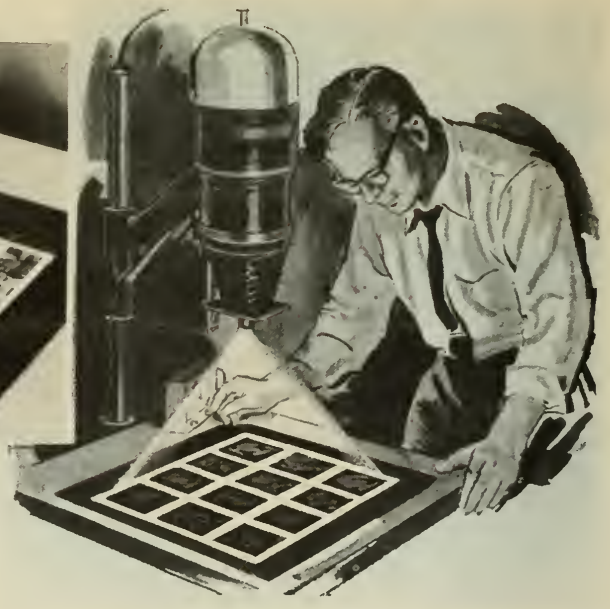
When original has printing on both sides, back the copy paper with black cloth to prevent double image

Develop until impression comes out boldly. If no impression shows after 30-60 sec., lengthen exposure

black paper or cloth is used when the original has printing on two sides. Placed underneath, the black backing prevents the light from reflecting back to the sensitized paper and picking up unwanted printing on the reverse side. The glass is placed over the original to keep it and the reflex paper in close contact so that sharp reproductions will result. The bulb should be suspended about 3½ ft. above the work and the paper exposed for six to eight seconds. The reflex paper becomes a paper negative when developed, from which regular positive prints can be made. To reproduce copy with printing on one side only, such as a letter, remember that the paper reflex is placed emulsion side up. To reproduce copy with printing on both sides, such as the page in a book, the reflex paper is placed on the copy, emulsion side down. ★ ★ ★

When copying from curved surface such as a can label, rotate can slowly to assure uniform exposure

Copy gives view camera cannot take. Note "panning" effect apparent on copy, right, made by reflex method



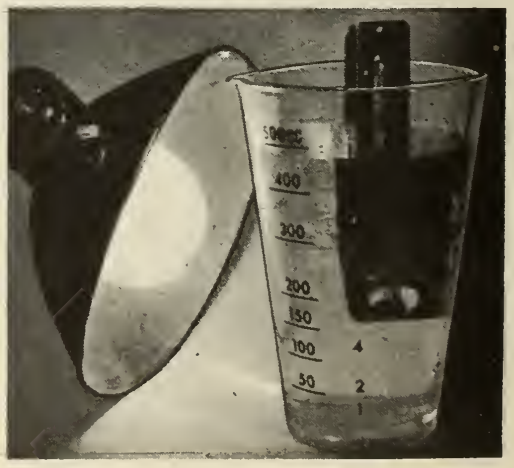
To make contact prints from wet negatives, wet enlarging paper is placed on ferrotype plate, after which negative strips are placed on top of paper, emulsion to emulsion, and exposed with the enlarger light

QUICK CONTACTS FROM WET NEGATIVES

For the photography hobbyist who wants contact prints in a hurry, here is an easy way of producing them without having to wait until processed negatives are dry. An enlarger and a ferrotype plate are the only pieces of darkroom equipment needed to do this. Begin by immersing an unexposed sheet of 8 x 10-in. enlarging paper in water for a few minutes. Then, allow it to drain while cutting the film into strips of four frames. Place the paper, emulsion side up, on the ferrotype plate and arrange the negative strips on top, emulsion side down. Wipe lightly with a damp sponge to flatten the negatives. Then expose the paper in the same manner as when using a contact printer. After exposure, immerse the negatives and paper in water to separate them, as the emulsion surfaces tend to adhere to each other.—G. Robert Smith

Bandage boxes of the type shown make handy pocket-size carrying cases for 35-mm. film cartridges when they are removed from their containers and wrapped in metal foil. One box is used for unexposed film, one for exposed. — Walter E. Burton

Solutions for film processing can be warmed to the correct temperatures quickly and easily by beaming a 100 to 200-watt light bulb on the solution in a graduate. Use a gooseneck desk lamp or photo flood reflector to concentrate the heat.



1

In the darkroom you spend considerable time working either in total darkness or in very subdued light. Likely you know the place as well as you know the inside of your pocket but unless there is adequate storage space you may discover at a critical moment that some needed item has been mislaid. Groping for it in the dark may give you ideas about how things should be arranged. Here are good, practical suggestions that will help

PLANNING THE DARKROOM

2

INVESTMENT ALONE won't make a darkroom easy to work in, but a carefully planned darkroom, even one very modestly outfitted, will enable you to save time as well as money. Also a darkroom well planned may enable you to improve the quality of your work. For example, vibration caused by a machine in the building may be fogging enlarged prints. If the darkroom is in your home, the motor of an electric refrigerator or automatic heating plant might transmit enough vibration through a floor to your enlarger to cause this trouble. Traffic on a busy street also could set up a vibration that would affect an enlarger. To prevent this, place thick pieces of sponge rubber under either the enlarger or the feet of the table on which it sets. A simple layout with all materials and equipment conveniently at hand is best. Figs. 1 to 4 inclusive are good examples.

Most photographers— amateurs and professionals alike — are inventive and resourceful. Their ideas on darkroom time-

Keep extra trays on shelves under the sink board. With this arrangement it won't be necessary to stack them one on top of the other. If you turn each one upside down it will always be dry and free from dust

Reaching for a metal pull chain on an outlet-box switch with wet hands isn't accepted practice in the safe, workable darkroom. Attach cords to switches and let them swing above your head within easy arm's reach

savers are worth studying closely. In a few darkrooms you will see a complicated system of light switches. Some of these may be located where wet hands must grope near an electrical outlet box or reach high for a metal pull chain. Not so good, in fact, this arrangement could be dangerous under certain conditions—maybe a wet floor or faulty wiring. A better, handier and safer arrangement is shown in Fig. 4 where the lights are operated by cords attached to the switch and to the wall so that they swing at an easy-to-reach height above the operator's head. In the course of average work in the darkroom, you will often find it necessary to turn on a white light. Unless this light is shielded effectively you'll be momentarily blinded. Not only inconvenient and uncomfortable, but a serious strain on the eyes if continued for any length of time. It's a simple matter to rig shades over or around the lighting fixtures so that light will be directed upon the work.

When processing prints, it's annoying to have to fumble under the sink for the necessary trays. Build a rack for them under the sink board where they can lie upside down, Fig. 3. That way they'll stay dry and they won't get dusty. Wastebaskets that permit discarded wet prints to drip puddles on the floor are troublemakers. A basket too small to hold an evening's quota of discards is a time waster. Get one that's big enough and make sure it's watertight. Install it under the drainboard where it's always handy.

If your darkroom "puts its mark" on your clothing, it is possible you can save expense by fastening buffers around the sink and drainboard. Measure the edges and buy towel racks, or make them of ¾-in. dowels. Fasten to the business edge of the sink and drainboard where they will protect your clothing as you lean over the work. To further protect your clothes and to add a handy accessory, hang thick towels over the buffers by thumbtacking one end of each towel to the lower edge of the board and draping the towel over the buffer as in Fig. 2. Run a splash bead or rail around the edge of the drippy area, to prevent chemicals from slopping over onto

5—Frames screened with galvanized wire and built into the space under a table provide a convenient means of drying matte prints between blotters

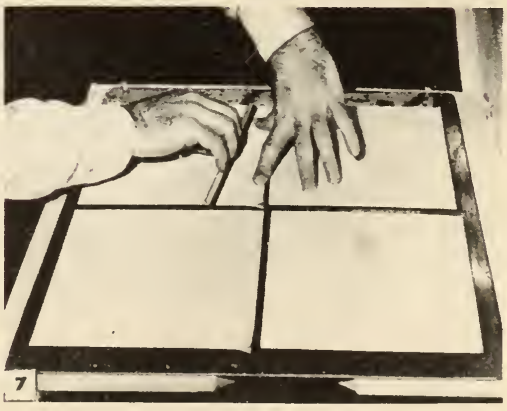
the floor. Rubber aprons are clothes-savers, too. You'll see them in many a good darkroom. The money they save in clothing and cleaning bills can be invested toward a new print trimmer or maybe a box of matte paper.

If your darkroom has a concrete floor, you can cushion your feet by wearing wool socks and thick-soled shoes. Or better, do a little light carpentry. Nail 2-in. strips on crosspieces, with ½-in. spaces between strips, to form a springy floorwalk. There's a lot of footwork in the darkroom and a little attention to comfort at floor level pays real dividends.

Many a darkroom boasts an imposing collection of thermometers, but often lacks the one that it should have. That's the one hanging on the wall near the developing tray. Air temperature acts on open trays of developer, regardless of how many heaters or chillers you may have. With a thermometer

6—To prop the wash tray at a more convenient height use glass jars with screw tops. Level the tray by turning the screw caps up or down

7—A windshield wiper is just the thing for squeegeeing wet prints. Treated in this way, prints will dry between the blotters in less than half the time



8—This hinged shelf supports a ferrotype tin while prints are being placed an it from the wash water. The drippings naturally run into the sink

9—An addition to the drainboard folds back against the wall when it's not needed. This makes extra floor space available for any other work

10—Plug-in outlets are a convenience, and thought must be given to the location of each one. All wiring should be installed in thin-walled conduit

11—Correct temperature for developer is important. If darkroom temperature varies, use a baby-bottle warmer. It warms the solution in a jiffy

telling you what's happening to the air temperature, it's easier to keep watch on temperatures of the stop-bath and hypo.

Those hard-working blotters deserve a place all their own. Frames screened with galvanized wire, built into the space under a table or wide shelf, provide means of drying matte prints between blotters or under blotters, Fig. 5. Then too, you can sandwich ferrotype tins between them to save the tins from accidental scratching.

Raising the wash tray a few inches above sink-board level for protection against splashing is simply and quickly accomplished by placing three or four glass jars under the tray. To level a tray on a sloping surface, put screw-top jars under it and adjust the tops until water level in the tray looks right, Fig. 6.

For speeding up the drying time of prints, give them a squeegeeing with a windshield-wiper blade before rolling the prints under blotters. You'll save wear and tear on the blotters and you'll keep the floor drier. Do the squeegeeing on a ferrotype tin, Fig. 7.

Slapping wet prints on ferrotype tins always has been a swampy part of photography. You can eliminate much of the dripping by building a hinged drainboard to hold the tin while you're putting the prints on it, Fig. 8. Let it drain into the sink. A half-moon shape cut from the upper end of the board will give you a place to take hold of the slippery tin. Two screws near the lower edge will prevent the tin from sliding into the sink. Hinge the board to the wall and provide a hook or cleat to hold it up out of the way, Fig. 9.

One of the stand-by items in the average darkroom is the rubber roller for rolling wet prints under blotters. A useful, indispensable tool, but it's always in the way unless a special place is provided for it. If you build a rack especially for the roller, where it will be at hand when needed, you add workability to one more phase of darkroom routine. Electrical gadgets are used frequently and they're great time-and-trouble savers. But if you have to rig up double or triple sockets and yards of extension cord, your darkroom will have the appearance of an ill-concealed booby trap. A few extra outlets in the electrical circuit will solve the problem. Because you'll be handling the electrical equipment with wet hands, foolproof wiring is essential, Fig. 10. See that those extra outlets are properly wired and insulated. To warm the developer, try an electric baby-bottle warmer, the kind that you immerse, Fig. 11.

It's only when you have the darkroom

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11

12

13

Left, shelves near the enlarger are handy for printing paper. Incidentally, build a platform like this to raise your enlarging easel to a convenient height It saves a lot of squint and stoop. Above, darkroom should have housed shelf compartments. They take more time to build, of course, but you've got to "live" with the furnishings a long time, so have them handy

open or the white lights on that a good paint job on the walls, ceiling and fittings shows up. But paint regularly applied helps keep the place clean. Use flat black on surfaces where you don't want glare. Walls and ceiling can be most any color desired. It's best to use a semiflat paint rather than a high-gloss finish. Keep the painting material handy in a cabinet like that in Fig. 14.

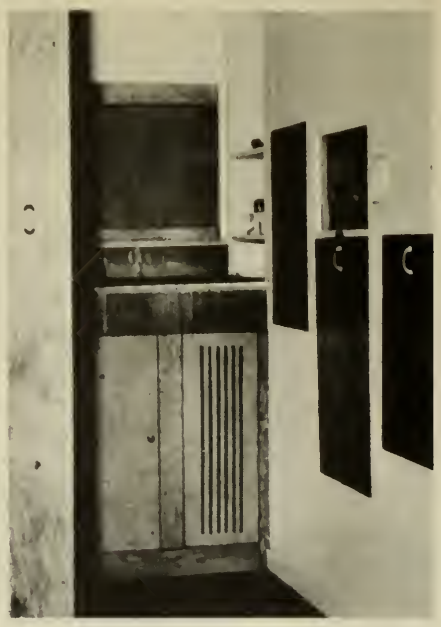
A considerable portion of your work in the darkroom is spent in focusing the enlarging camera. Unless the easel is placed at a convenient height, you have to bend your back and twist your neck. This kind of thing isn't permissible in the smooth-working darkroom. Take time to build a platform to raise the easel waist-high Leave the front open, and use the former table-top as a handy shelf, Fig. 1. If your enlarger is extremely high and cramped by a low ceiling, maybe a hole can be cut in the ceiling and boxed in to admit the lamp house.

14

Because they are of top-heavy construction, enlargers have a tendency to wobble. A wobbly enlarger wastes time and good printing paper. Vibration can be avoided by applying sturdy braces of flat iron to the top of the enlarger column. Two extra feet will provide a wobbleproof stance. Fasten the braces to the wall or ceiling, where they will be out of the way.

Spare corners are good spots for shelves, Figs. 12 and 13. The average darkroom has sufficient space but often the furnishings are not arranged to make the most of the space available. Shelves help. Big ones or little, they are needed for storing supplies where they won't clutter up the floor. They simplify the filing problem. If you want real efficiency and have the space, build a darkroom annex to be used as a film room. It's a smaller version of the main darkroom, but limited to the loading and processing of films. It will permit two-man operation and will give your films a higher degree of protection from light, dust and chemicals. In this film annex, you can build a lot of workability into a small space. A hinged shelf will make a film-loading table,

Paper cutter is located in recessed cabinet at right end of sink. Ferrotype storage racks are below sink



View of the right side of the darkroom through the sliding door shows neat appearance of flush cabinets

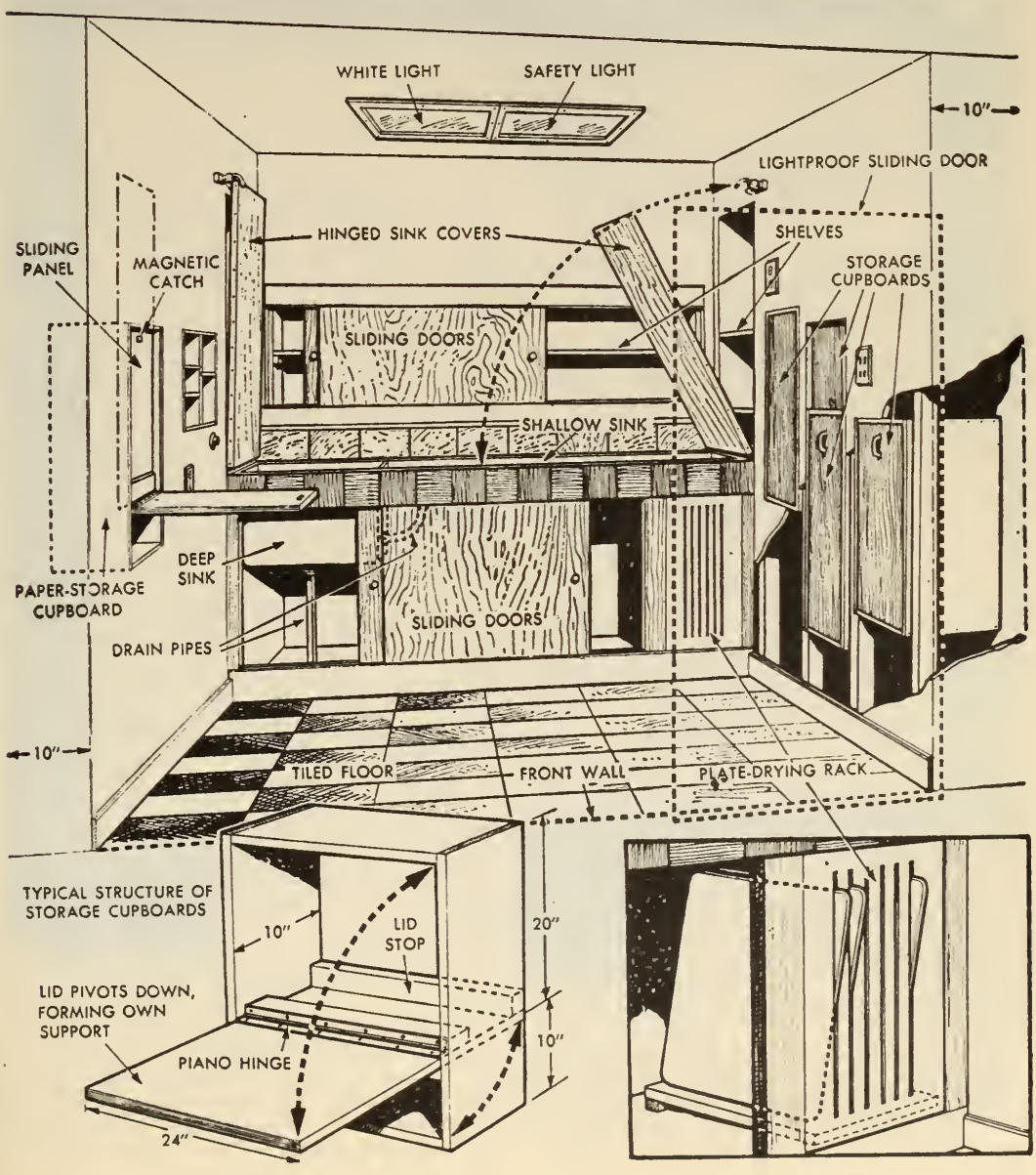
"Dream" Darkroom Takes Little Space

By William G. Waggoner

AFTER YEARS of using makeshift darkrooms in kitchens or bathrooms, I finally built a "dream" darkroom, in which were incorporated ideas worked out during the many frustrating hours spent with my improvised setups. A portion of a garage, an area measuring 8 x 10 ft., was used for the darkrooms, although any small area could be remodeled in a similar manner. Because nothing projects from the walls except the enlarger, a minimum amount of floor space is required for the dark room.

Typewriter was included in equipment in original darkroom, stationery is stored in cabinet above it

First step in construction is to build false walls 10 in. out from the original back and side walls. In this 10-in. space are located all the cabinets for storing equipment and supplies. Dimensions for all cabinets must be determined before the false-wall framing is erected, as the wall studs must be spaced to accommodate the widths of the various cabinets. All cabinets are built as indicated in the lower left-hand detail on the facing page, each one being simply a box assembled with glue and screws and screwed to the wall studs. The front edges of each cabinet project beyond the face of the studs the thickness of the material to be used as a wall covering. When the covering is applied, the cabinets will be flush with the surface. Dimensions shown on the cabinet in the detail are for one make of standard typewriter. Each cabinet must be dimensioned to accommodate the material or piece of equipment it is to contain. Note in the detail that the desk lid of the cabinet, cut from $\frac{5}{8}$ or $\frac{3}{4}$-in. plywood, is fitted with a piano-type hinge that is screwed to a cross piece attached just inside the front edges of the cabinet. The distance from the hinge center to the bottom of the cabinet is the same as the


WHITE LIGHT
SAFETY LIGHT
10″
LIGHTPROOF SLIDING DOOR
SLIDING PANEL
MAGNETIC CATCH
HINGED SINK COVERS
SHELVES
STORAGE CUPBOARDS
SLIDING DOORS
SHALLOW SINK
DEEP SINK
PAPER-STORAGE CUPBOARD
DRAIN PIPES
SLIDING DOORS
10″
TILED FLOOR
FRONT WALL
PLATE-DRYING RACK
TYPICAL STRUCTURE OF STORAGE CUPBOARDS
10″
LID STOP
20″
LID PIVOTS DOWN, FORMING OWN SUPPORT
PIANO HINGE
10″
24″

Hinged covers drop down to make sink a worktable. Cabinets are back of sink, shelves are at each end

distance from the front edge of the cabinet to the inside surface of the cabinet back. Thus, when the door pivots on the hinge, the lower end of the door rests against the underside of a stop at the back of the cabinet. With this setup, the cabinet lid is self-supporting, requiring no external braces or legs to keep it in a horizontal position. When equipment is fastened to the inside surface of the doors, as is the typewriter in the lower left-hand photo, page 1616, weight of the equipment will keep the door in the closed position without need of any sort of latch. The paper-storage cabinet, upper right-hand photo, page 1617, differs from the other cabinets by having an inner, light-tight door. It slides in grooves cut in the sides of the cabinet and through a slot cut in the top. Because no equipment is attached to the door, a magnetic latch is used to hold it closed.

Spacesaving Features

Another spacesaving feature of the darkroom is a combination sink-worktable. Two hinged covers of ¾-in. plywood, covered with linoleum or plastic laminate, form the worktable that swings up out of the way when the sink is used. Screen-door closers are used to hold them against the walls. The sink was custom-made at a sheet-metal shop, and is painted with liquid rubber on the inside. It has a deep and a shallow basin. The deep basin has a perforated pipe coiled in the bottom through which water is run, causing tiny jets of water to keep the tank water agitated for thorough print washing. Depth of the water in both basins is controlled by standpipes that consist of lengths of plastic tubing cemented in holes cut in sink stoppers. Water flowing in the shallow basin serves as a water-temperature control for the developer, stop bath and fixer chemicals that are in floating trays. Water from the shallow basin drains into the deep basin.

Cabinets under the sink have sliding doors that run on T-shaped tracks. Track of this type is available at most building-supply and some hardware stores. At one end of the sink cabinet is a storage rack for ferrotype plates, as indicated in the lower right-hand detail page 1617. Above the sink at the back and ends are shelves and cabinets for storage of equipment and supplies, as shown in the photo at the top of this page. Here again, the 10-in. space is used to good advantage. Sliding doors also are used on the cabinets back of the sink, open shelves are located at each end. Near the center of the left-hand wall of the darkroom is a shelf on which the enlarger is located. To its right are recessed shelves on which is kept material used with it. A timer is wired into an outlet box at the back of one shelf, which eliminates the need for any exterior wiring. The only cord showing is the one from the enlarger. A white light and a safelight are installed in boxes built flush with the ceiling. The door of the darkroom is a sheet of plywood that is suspended on nylon rollers from an overhead track. A cornice over the track, a recess at one side and at the bottom of the door, plus a felt strip along the other side, makes it light-tight. No recess is required for the full door, as it slides along the wall inside the darkroom. A hinged door also could be used, made light-tight and opening outward. ★ ★ ★

Dishpan Sink for Darkroom Beginner

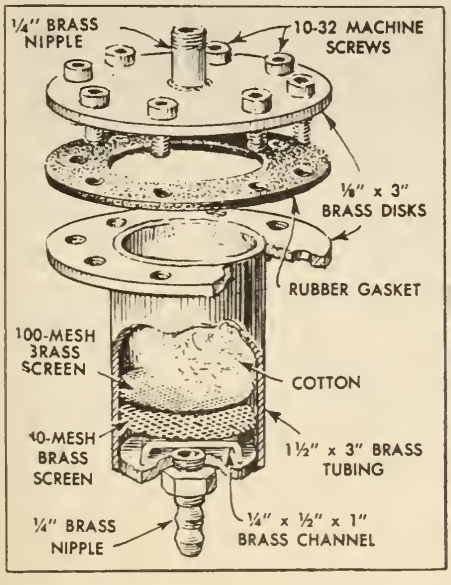
What to use for a sink without spending a lot of money poses a problem for the amateur photographer interested in setting up a basement darkroom. The answer is a plastic dishpan. The plastic is soft and easy to cut, making it a simple job to cut a hole in the bottom for a standard bathtub-drain fitting. The flange around the edge of the pan permits it to rest neatly in an opening jigsawed in a plywood or hardboard counter covered with linoleum. In most cases, water can be piped to the darkroom by adding a line and faucet to the existing plumbing, and the sink can be drained with a length of 1½-in. plastic hose into a nearby floor drain. In the latter case, a trap isn't necessary on the sink fitting.

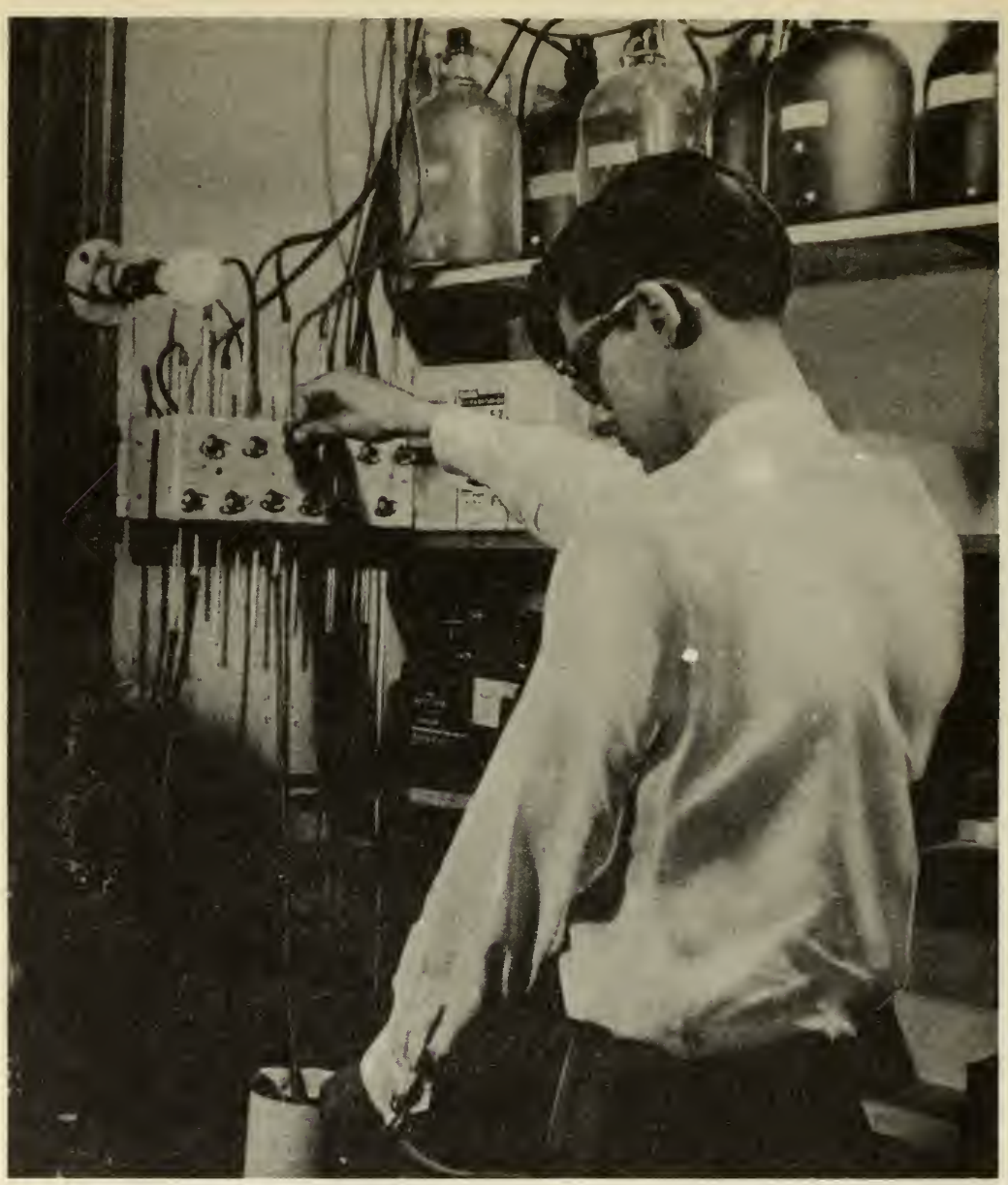
R. J. Phillips, Uncasville, Conn.

Filter on Faucet Assures Clean Water at Darkroom Tap

Clean water, free of rust flakes and other foreign particles, is important when it comes to processing film. Unfortunately, commercial filters are expensive and for this reason most amateurs use unfiltered tap water in the darkroom. However, an inexpensive and fairly simple water filter can be made as shown in the pull-apart drawing and attached directly to the sink faucet. Made entirely of brass, the body is a 3-in. section of kitchen-sink drainpipe which has a disk soldered at the bottom and a flange at the top. The bottom disk is drilled and tapped for a ¼-in. hose connection. The cover of the filter is held in place with eight capscrews turned into tapped holes in the flange. A gasket cut from an innertube goes between. A section of brass channel supports the filter screens and loosely packed cotton which filters the water.

Robert Michals, Freehold, N. J.



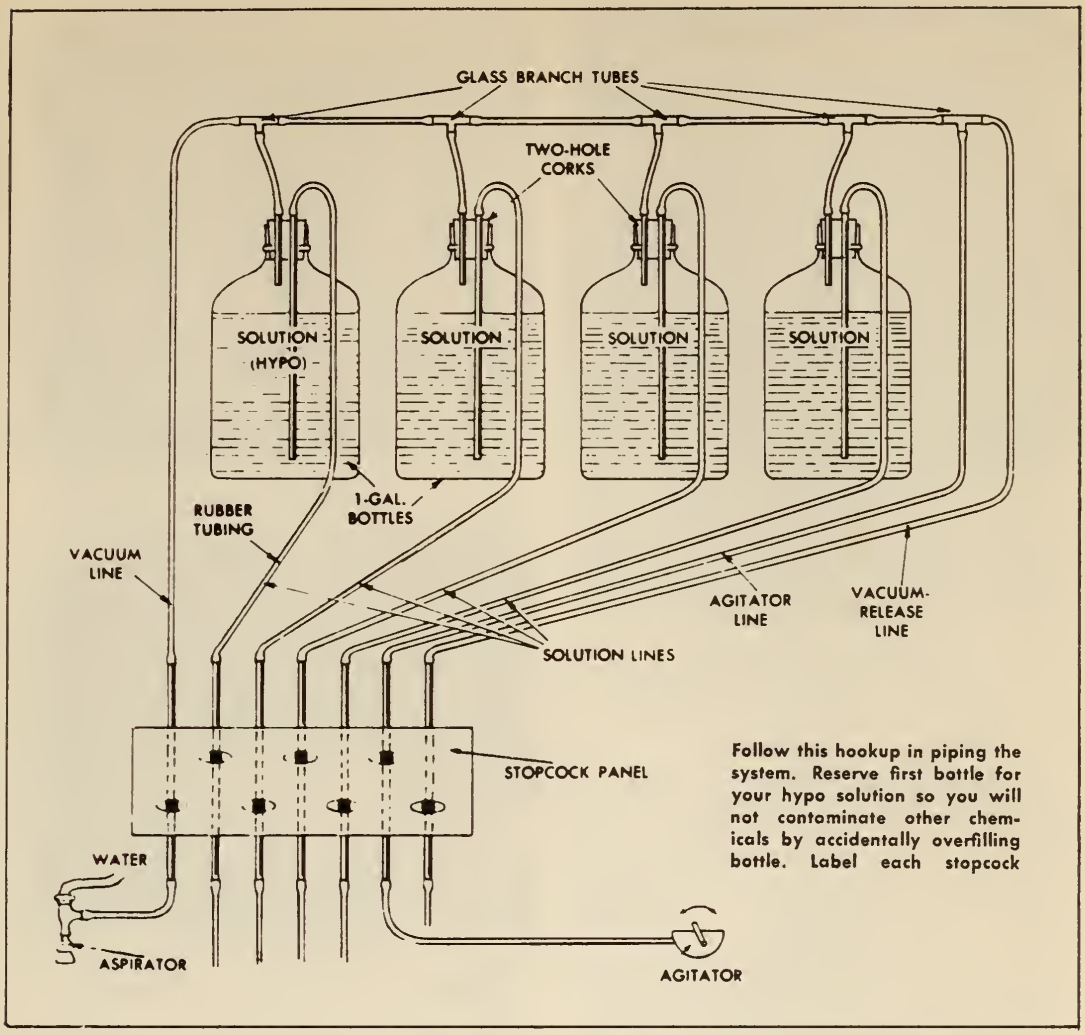


There are no bottles to handle in measuring out photo chemicals when they are kept on tap—just turn a cock

PHOTO CHEMICALS KEPT ON TAP

TURNING A VALVE to measure out photo solutions as you would a water faucet is a real darkroom convenience that will appeal to anyone who processes his photos at home. This is made possible with an easily installed vacuum-siphoning system which permits solutions to be tapped from stock bottles stored out of the way on an overhead shelf. The vacuum in the system is maintained by a device called an aspirator which is attached to the darkroom-sink faucet. Vacuum is created by running water through the aspirator. The vacuum also makes it possible to operate an efficient film agitator that is improvised from a windshield-wiper motor.

To install this system in your darkroom you'll need at least four 1-gal. bottles, seven glass stopcocks, four 2-hole corks to fit the bottles, five glass branch tubes, an aspirator and ¼-in. rubber and glass tubing. The glass stopcocks are the valves which control the flow of solutions kept on tap. All seven stopcocks are cast in a



plaster-of-paris panel. A shallow cardboard box makes a good form for the casting as it can be easily stripped off. Holes are made in the sides of the cardboard box to insert the glass tubes attached to the stopcocks and the latter are positioned in the box in the manner shown in the drawing above. Pieces of wire and bits of metal mixed in with the plaster will reinforce the finished casting. Finally, each stopcock is labeled with the name of the solution it is to deliver, and the block is mounted at a convenient height on the darkroom wall.

Piping the System

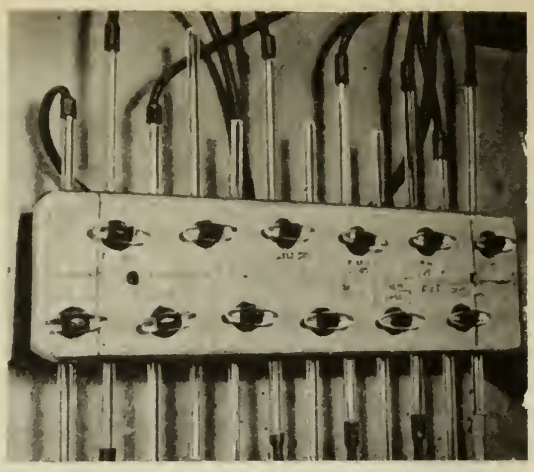
The diagram above shows clearly how the stopcocks are connected with rubber tubing to the bottles, aspirator and agitator. You'll notice that each bottle cork is fitted with two lengths of glass tubing, one being long enough to nearly touch the bottom of the bottle.

Be careful in pushing the glass tubes through the holes in the corks. Wetting the corks with water will help make the tubes slide through easily, but you should take the added precaution of wrapping the tube and cork with a towel to protect the hands in the event a tube should break.

The vacuum of the system is controlled by the stopcocks at the ends of the panel, the one on the left being labeled vacuum and the one on the right, vacuum release. After each bottle is hooked into the vacuum line and connected to its respective stopcock in the manner shown in the diagram, the aspirator is connected to its stopcock and the agitator to its stopcock. The rubber tubing at the lower ends of the stopcocks should be long enough to reach into the darkroom sink.

The windshield-wiper motor is rigged up to rock a tray platform placed in the bottom of the darkroom sink. A bracket to hook it over the edge of the sink can be formed of coat-hanger wire and another piece of wire is used to connect the platform to the rocker arm of the motor. The platform can be either wood or metal, and a cork fastened to the underside at each end will provide pivots on which it can rock. To make the agitator work, turn on

Aspirator screws onto sink faucet and is connected to stopcock panel with length of rubber tubing



Stopcock panel controls flow of siphoned chemicals. Rubber tubing slips over ends of the glass tubes

the water faucet so water will run through the aspirator and open the stopcock labeled agitator. Adjust the flow of water through the aspirator so the agitator will rock the tray with a slow periodic movement. Avoid rapid agitation when developing film as this may cause flow lines on the surface.

Operating the System

To siphon solutions into the bottles, a vacuum must be created by running water through the aspirator. All stopcocks must be closed except the one which controls the bottle you are filling. As the vacuum increases, the solution will flow more rapidly into the bottle. Do not attempt to fill the bottle too close to the top or you run the risk of pulling the solution into the vacuum line and out through the aspirator. When the bottle is full, close the stopcock.

Don't let the container from which you are drawing the liquid become completely empty so as to draw air into the bottle. A column of solution must be left standing in the glass tube of each stopcock that delivers solution.

Let the first bottle of the group hold hypo. This will prevent any chance of the other solutions becoming contaminated should you accidentally overfill the hypo bottle. By keeping it first in line, any excess hypo will merely flow out through the aspirator. To insure cleanliness of the bottles after having exhausted the supply, draw some clean water into the bottle and drain it out again before refilling.

Agitator is made from windshield-wiper motor and vacuum-operated by running water through aspirator

To tap the stock bottles, first open the vacuum-release stopcock and then the stopcock of the particular solution you wish to use. Should the tubing have no solution standing in it, turn on the water faucet and pull some water into the tube. Then release the vacuum again and the solution will flow. When not being used, seal off the system under a vacuum. This will help prevent oxidation of the chemicals that oxidate under normal air pressures. ★ ★ ★

Strong Hypo Substitutes for Rapid Fixing Solution

With the new single powder acid fix on the market it is possible for photographers to mix a double-strength hypo and get the same effect as a rapid fixing solution, and at less cost. The hypo mixture has none of the caustic properties of the ammonium-chloride rapid fix and has none of the corrosive effect of the latter. By using this double-strength hypo, films will clear equally as fast as when treated with a rapid fix, and the hypo will actually last three to four times longer than a mixture of normal strength. When used on prints, the bleaching characteristics of a rapid fix are not present and the time allowance for immersion of the prints is not a controlling factor. A mixing ratio of acid fix, two parts to water, one part, is suitable for most general requirements.

LUMBERYARD PICTURE FRAMES

There are picture frames galore waiting for you at your lumberyard at a fraction of the price you would pay at a store. Stock builders' moldings offer a wide selection of shapes at pennies per foot

By E. R. Haan

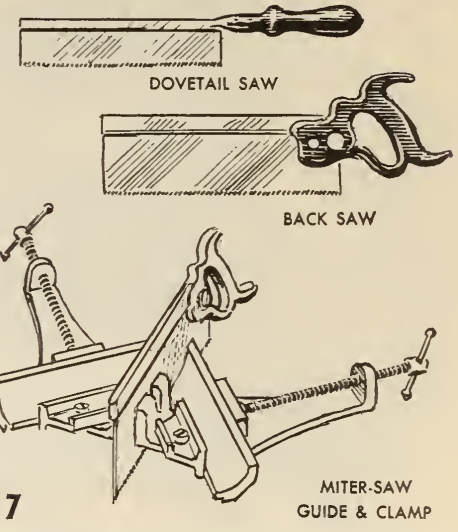
WHO WOULD THINK of going to a lumberyard for picture-frame molding! But there you'll find an array of standard molding shapes that will frame your pictures for a song. Priced by the foot, the molding is nicely shaped from choice grades of pine and other woods and needs only to be mitered to length, Figs. 1 through 5. Some moldings are already rabbeted, on others the rabbet is formed with a second molding, Fig. 8. All have one thing in common, they're comparatively inexpensive.

6

Figuring Molding Lengths

To determine molding length required for a desired glass size, add the height and width of the glass and multiply by two. To this add the width of the frame multiplied by eight. For example, in case of an 11x14-in. glass-size, twice the height and width is 50 in. For a frame 2 in. wide, add 16 in. to 50, totaling 66 in. or 5½ ft. to allow for waste.

Unfinished molding to be given a transparent coating should receive a coat of sealer to avoid stains from glue. Many



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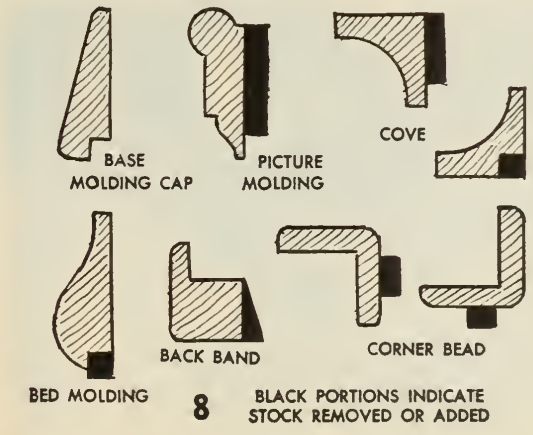
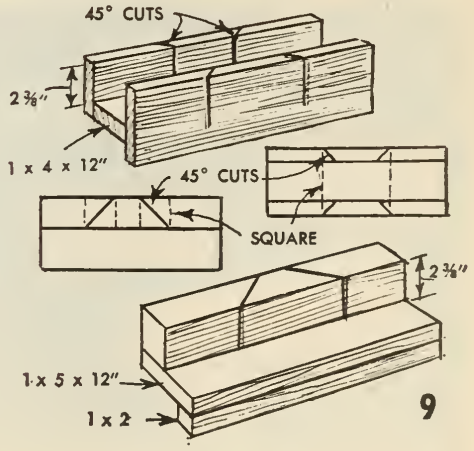


8 BLACK PORTIONS INDICATE STOCK REMOVED OR ADDED



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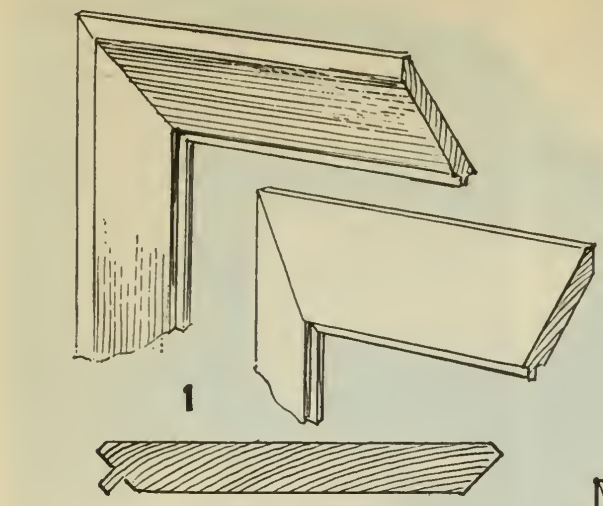
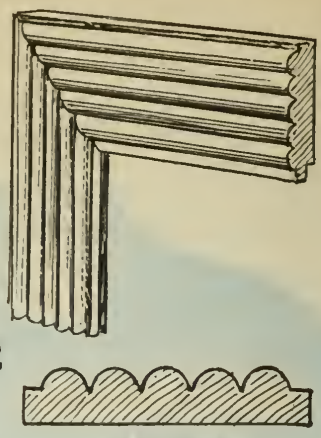


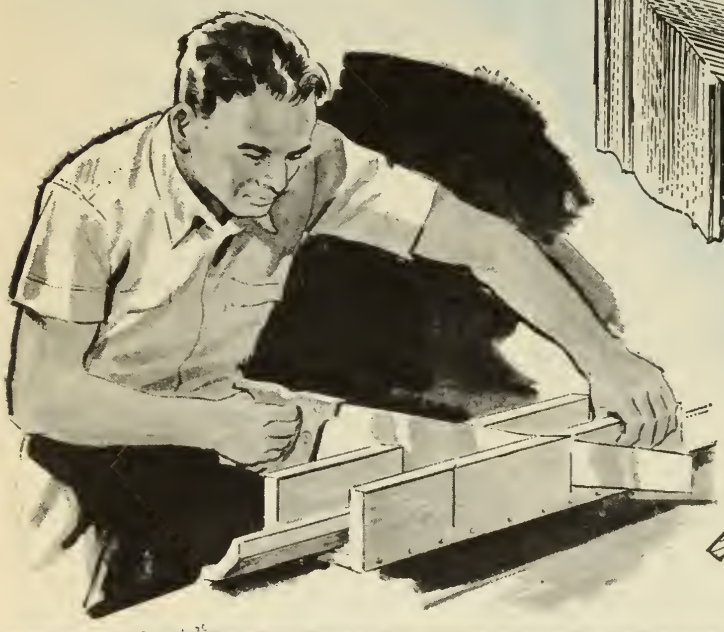
1

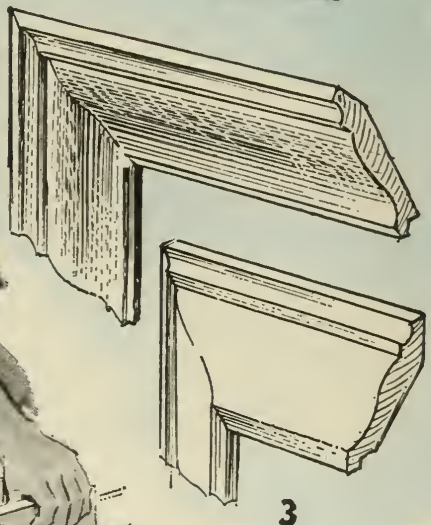
STOCK 1" LUMBER



2

FLUTED CASING





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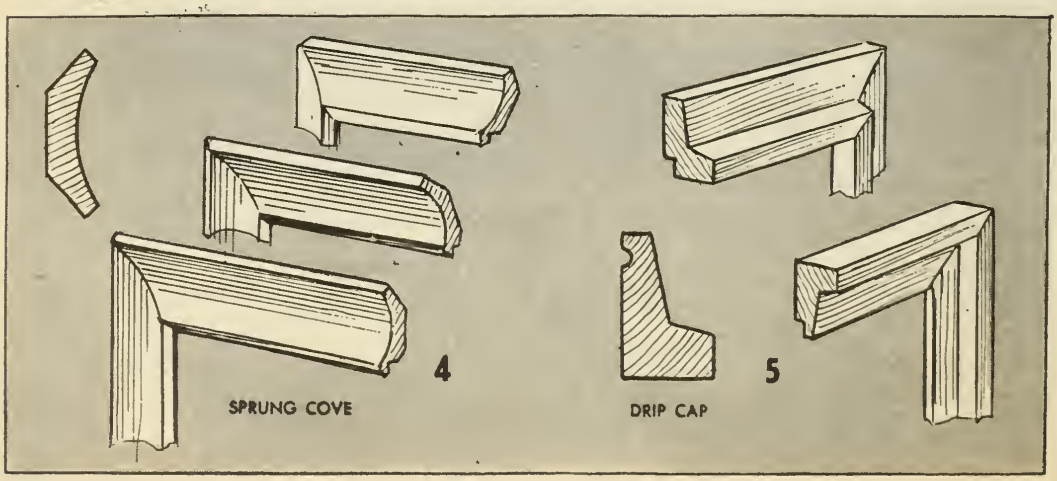
CROWN MOLDING



4

SPRUNG COVE

5

DRIP CAP

10

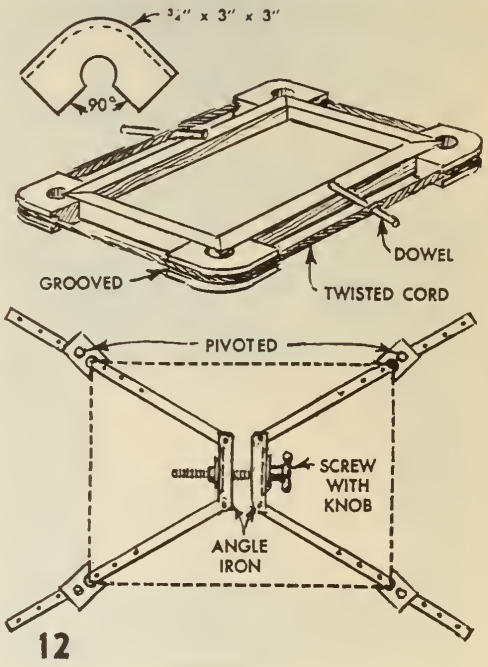
11

pleasing effects are obtained by making the grain of the wood contrast with a colored, semitransparent toner. Molding also can be covered with self-adhering sheet plastic having an imitation-wood finish.

Guides for Miter Sawing

If you haven't a circular saw to cut miters accurately, use a fine-toothed handsaw such as a dovetail or back saw, Fig. 7, plus a suitable miter-sawing guide. Fig. 7 also shows an inexpensive combination miter-sawing guide and clamp.

A homemade miter guide and miter box are shown in Fig. 9. The dimensions given are intended for a back saw having a cutting depth of 2½ in. To mark a block or box for cutting the 45-deg. saw kerfs, use a sharp pencil to make perfect diagonal gauge lines as in Fig. 9. Also draw vertical lines on the sides for checking the cut while sawing. The 45-deg. kerfs in the guide should be made by the saw to be used in them or one of identical thickness and set. One edge of the kerf should be right on the fine diagonal lines.



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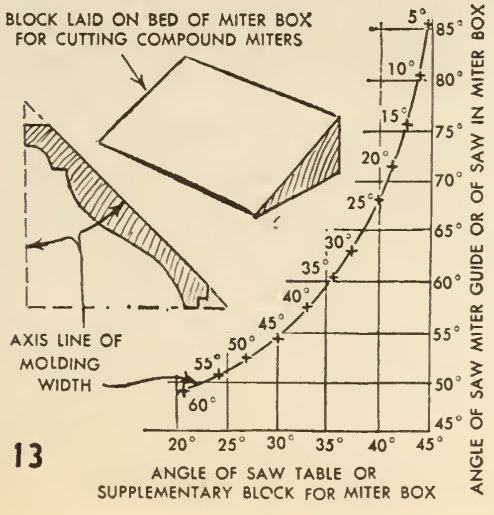

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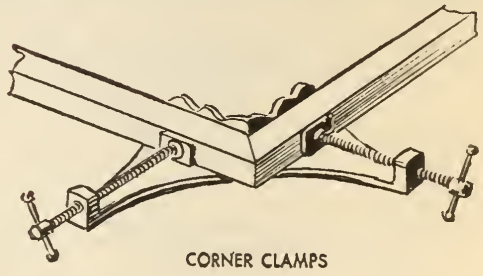

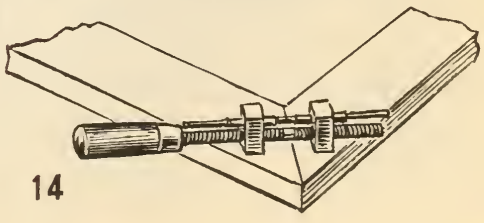

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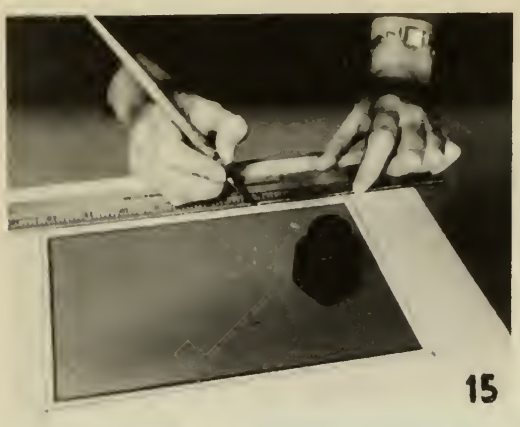

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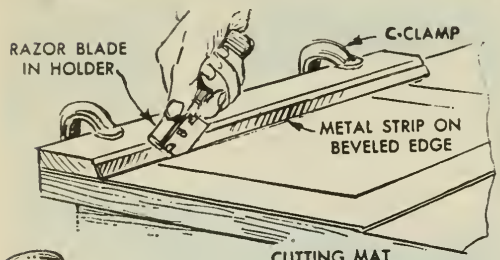

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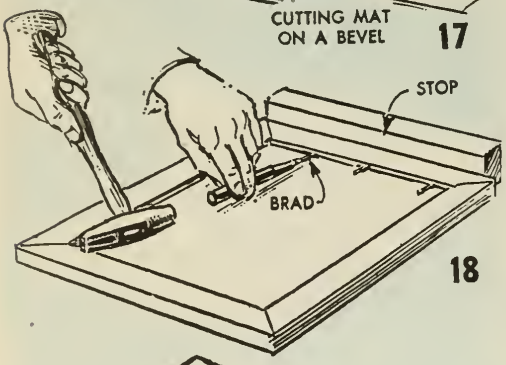

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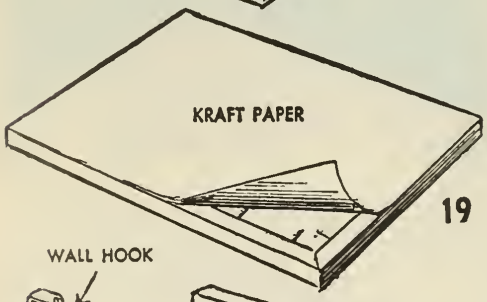

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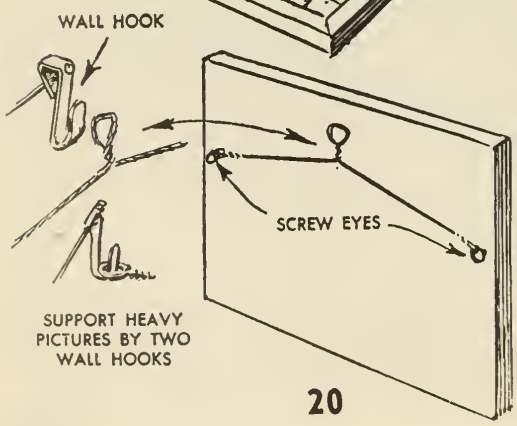


20

Using Miter-Saw Guides

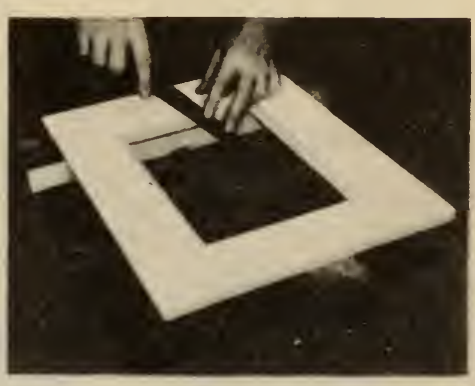
Place the molding in the miter-saw guide or box so its back rests on the bottom and one edge comes snugly against one side. The molding must be held immovable—preferably clamped—in this position while sawing. Start the cut by drawing the saw backwards to prevent chipping the molding. To avoid a ragged back edge, place the molding on a strip of hardboard. If this is not done, the ragged edge must be removed carefully with fine sandpaper. Smoothly cut miters do not require sanding or planing, which sometimes changes the bevel or causes other damage.

Laying Out Frame for Cutting

For aligning the molding visibly, with the saw at the point where it is to cut, mark the outside edge of the molding. After cutting off one end at 45 deg., locate the mark for the next miter cut as follows: Measure the width of the molding from the outer edge to the bottom of the rabbet but not to the inner edge of the molding. Add twice this distance to the length of one edge of the glass, plus $\frac{1}{16}$ in. for clearance. This gives the exact length of the molding along the outer edge from the corner already cut.

Compound Miters

Hopper-type frames require compound miter cuts. Lacking a circular saw with its accurate miter gauge and tilting arbor you can use a sloping block in a miter box, Fig. 13. When cutting compound miters, use a miter box that is adjustable. Extreme accuracy is highly important for sawing compound miters. For frames having sides that slope 45 deg., the miter-gauge or miter-saw angle is $54\frac{3}{4}$ deg., while the table tilt or the angle of the supplementary block in a miter box is 30 deg. You can find this in graph, Fig. 13, which covers various slopes of picture frames.



21

Assembling Frames

Check the four lengths of molding for accuracy. Assembling the pieces with glue and brads or finishing nails of suitable size is next. Often, small nails can be driven into soft molding without splitting it, even though no pilot holes are provided. But to forestall the risk of splitting, pilot holes are available, especially in hardwood. Generally a pilot hole needs to extend only from the outer edge of the molding to the miter cut—not into the joining molding.

After both pieces are glue-coated, place them together in a corner clamp, Figs. 10 and 14. Leave the molding in the clamps until the glue has dried.

Miter clamps that draw up the four corners of a mitered frame are shown in Fig. 12. However, when using these you glue the corners first but do the nailing after the glue has dried and the frame is removed from the clamp. For nailing, hold each side of the frame in a vise, using smooth, protective strips of hardboard on the finish side.

You can also glue and nail all corners of a frame freehand. To join corners freehand, chuck one member in a vise, using a protective pad against the molded surface and a backing piece such as plywood, Fig. 11. When joining molding, wipe off all excess glue with a damp cloth.

Mounting the Picture

Most pictures look best when offset by mats. Almost any thick paper of dull finish, preferably textured, will do. Thin paper is apt to buckle from moisture absorption. Best material to use is regular mat board. Interesting wood-grain and marbleized effects on mats are possible by covering cardboard with self-adhering sheet plastic. Another attractive effect is obtained by using ⅛-in. perforated hardboard against a colored background.

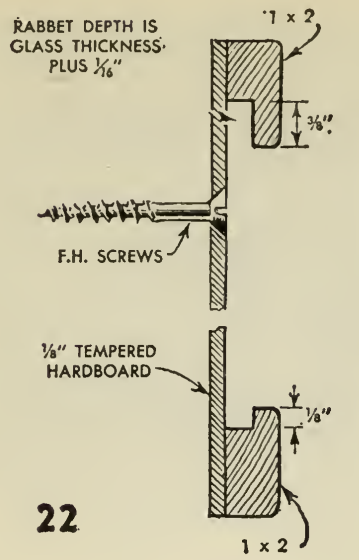
The picture should overlap the mat no less than ⅜ in. Cut openings in matboard with a sharp razor blade held in a substantial holder; run the blade along a metal straightedge. For an angle cut, use a beveled straightedge as in Fig. 17. Mats often can be improved by black or colored ink lines drawn close to the edges as in Fig. 15. The picture is fastened to the mat with glue or removable tape.

The backing may be cardboard or corrugated board to bring the surface a trifle below the edge of the frame to permit the backing to be fastened with brads. On small frames you can push brads in gently with pliers, Fig. 16. For large frames, use a light hammer and punch, Fig. 18. After the brads are in place, seal the back of the picture with heavy paper to keep out dust, Fig. 19.

Screweyes used for hanging pictures generally are located from a third to a fourth of the picture height from the top edge as in Fig. 20. A loop formed at the center of picture wire as in Fig. 20 keeps a picture hanging straight, Fig. 6. Heavy pictures should be supported by two hooks.

Novelty Frames of Softboard

Attractive picture frames without glass, Fig. 21, can be made of soft wallboard. The outside edges are cut on a circular saw and then smoothed with sandpaper. The beveled cut is made as follows: Mark the position of the innermost edge on both



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sides and cut halfway through the board from each side. Place the frame on blocks as in Fig. 21. With the finish side up, a medium-coarse file is used to dress off the beveled edges. Such frames are hung by gummed eyelet tabs as shown in Fig. 24.

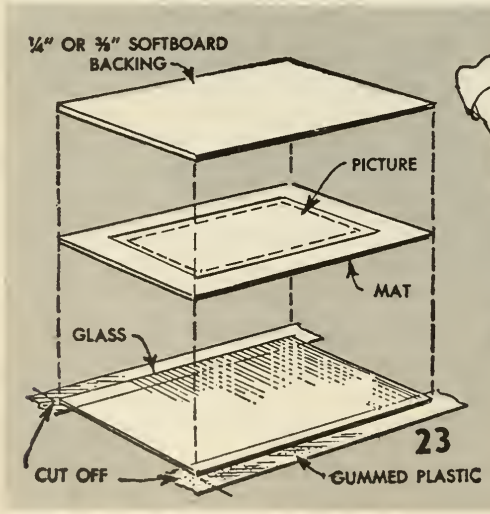
Gang Frames

The frame in Fig. 22 holds several pictures of equal size and permits them to be exchanged quickly. Each picture is set behind a glass pane of the same size. Both are inserted into the upper rabbet and dropped into the shallow rabbet in the lower molding.

Imitation Frames of Sheet Plastic

Imitation wood frames can be made from strips of gummed sheet plastic. A backing of softboard gives the desired thickness, Fig. 23. Place the glass carefully on the two strips. Hold the glass, mat, and backing together firmly while turning the assembly over. Next, apply the two other strips to the glass. Before fastening these to the back, make a miter cut at each corner with a sharp razor blade to eliminate overlap, Fig. 25. To minimize opening mitered joints, avoid stretching the tape lengthwise when applying it. Pictures so assembled are provided with gummed eyelet tabs for hanging.

Besides the imitation wood tapes, many other colorful plastic tapes are available. When a decorating change is wanted, simply add a new tape to the frame. ★ ★ ★



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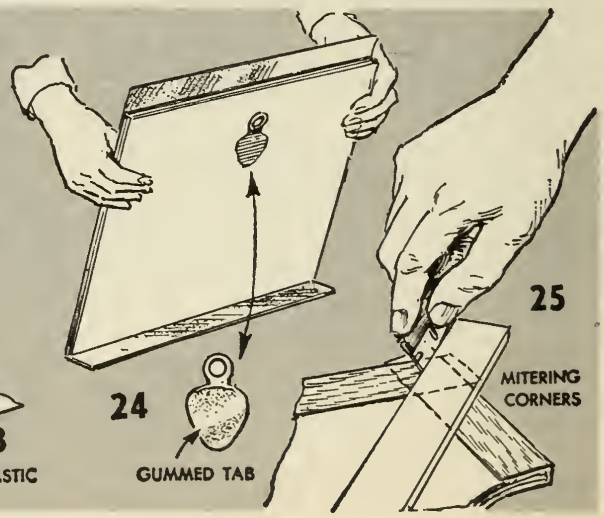

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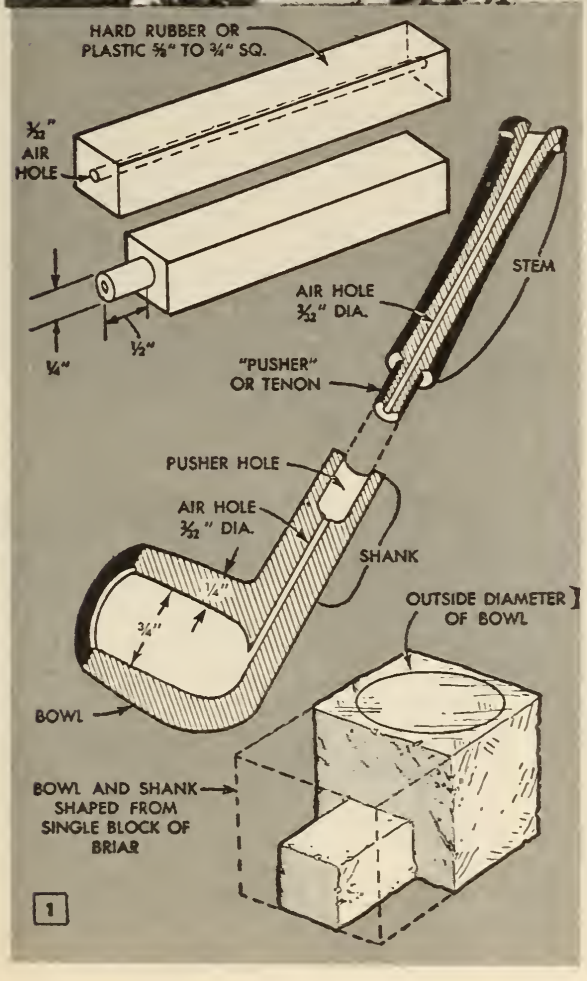
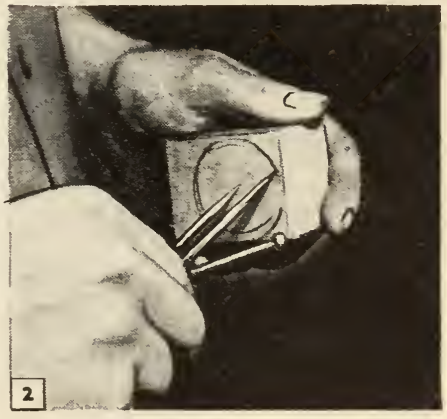
MAKING AND REPAIRING BRIAR PIPES

Pipecrafting calls for the craftsman's touch but anyone can make a good pipe with only a few tools—also repair that favorite old briar



GENUINE briar, as used in pipemaking, is a tough, hard rootwood and comes in pieces of comparatively small size. The grain in a single piece may vary from a distinct burl or "flame" figure through several gradations to a plain, flat grain. In cutting the rough blank for a pipe of conventional design from any but the choicest blocks of briar, the pipe maker often must modify the design to eliminate flaws in the material, or to take full advantage of the variations in the grain.

The bowl and shank of the conventional pipe are shaped from a



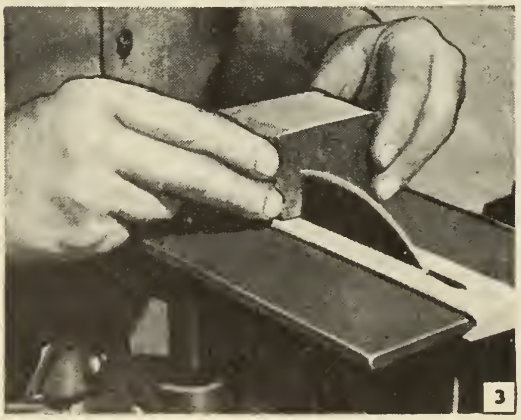
Scribe the inner and outer diameters of the bowl on the blank with sharp-pointed scriber

single blank of briar, Fig. 1, but the stem, or bit, usually is a separate part made from hard rubber or plastic. The bit is flattened at the outer end to form a comfortable mouthpiece. The air hole, usually 3/32 in. in dia., is drilled lengthwise through the bit before the final shaping. Before cutting a blank of briar to the rough shape, examine it carefully for flaws and pattern of grain. Then square the top surface which is to be the top of the bowl. Scribe the inside and outside diameters of the bowl on the wood, Fig. 2. In sawing the blank to the rough shape, Fig. 3, make the first cut from the end of the shank to the bowl and the second down from the top of the bowl to meet the first cut. Allow waste for shaping the bowl and shank to exact size. Shape the shank roughly by running additional cuts in from the end of the shank to the bowl. Then two cuts run in from the outside to meet the last two at the shank will produce a blank shaped as shown in Fig. 4. Next, mount the blank in a special chuck in the lathe and bore the tobacco hole as in Fig. 5. Round the bottom of the hole to a uniform radius. Counterbore the shank while the work is still in the blank or make a special chuck to hold the semifinished part as in Figs. 7 and 8. Counterboring forms the air hole and the pusher hole as in Fig. 1.

Now the blank is ready for shaping, which is done on a recessed wooden disk faced with abrasive, Fig. 6. Both the outer face of the disk and the recessed center are coated with abrasive grains bonded to the surface with a special adhesive. In use, the speed of the abrasive disk should not exceed 2000 r.p.m., otherwise there is danger of burning and discoloring the work. The

When sawed to rough shape, the completed shank-and-bowl blank is ready for sanding to final form

Boring the tobacco hole in the bowl, using a special chuck. Bottom of the hole is rounded uniformly



Next, the rough blank is sawed to shape with a circular saw. Be sure to allow stock for finish-sanding

Final shaping of bowl and shank is done on a recessed abrasive disk made especially for the purpose

After final shaping, the work is clamped in a specially made chuck tightened with a friction ring

Counterboring the shank to form the air hole and the pusher hole. Pusher hole must be of exact diameter

shaping procedure is simply that of bringing the shank and the bowl gradually to the rounded contours by alternately rounding over the corners of both shank and bowl. By working in this manner, the bowl and shank can be brought accurately to uniform shape and size.

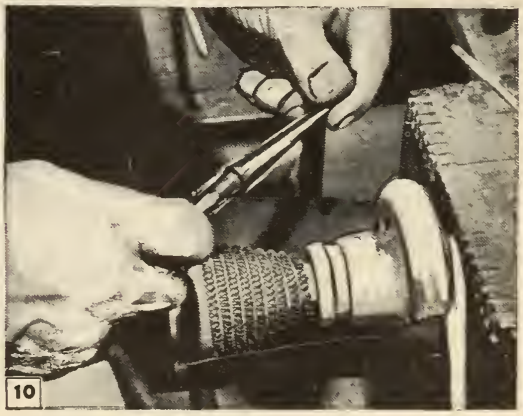
At this stage the stem should be shaped. This is done on the abrasive disk but special care is taken to avoid overheating. Some hand-finishing will be necessary after assembly of the pipe. Turning the tenon to fit the pusher hole in the shank is the tricky job, but with care it can be done in a special chuck mounted on the lathe faceplate. Make several trial fits as in Fig. 9. After the stem is fitted to the shank, press it into the shank and touch lightly to the abrasive disk, Fig. 11, to finish the joint flush. If the stem fits too loosely, expand the end by heating it and inserting a metal taper pin as in Fig. 10.

High-grade pipes of fine briar usually are oil-finished and polished by hand. To do this, mix fine pumice and sweet oil to a light paste and rub the bowl, shank and stem to a high luster. That's all. The pores of the wood in a good pipe should never be sealed with varnish or lacquer.

Figs. 12 to 18 inclusive detail the methods of repairing common breaks in the stem and shank. If the stem tenon snaps off, leaving a portion in the shank, Fig. 12, just square the broken end and turn a new tenon on the stem. A second method is the use of an insert tenon as in Fig. 13. If the stem is short, this method often is the best. If, on the other hand, the shank breaks close to the stem, cut the shank as in Fig. 14 and drill a new pusher hole. Pipe repairers often add a metal band, Fig. 16, as a part of this repair. When the shank breaks close to the bowl, the repair problem is somewhat more involved. Then the repairman uses what he calls a bone screw, which is merely a coarsely threaded tenon or dowel made from bone and available from pipe suppliers. Broken ends of the shank are squared and joined as in Fig. 15. Use a waterproof glue and, as soon as the glue has dried thoroughly, refinish the shank and stem on the disk as in Fig. 11, to

The stem is held in the same chuck when turning the tenon. Always trial-check the fit in the pipe shank

If pusher fits too loosely, expand it by holding the bit over heat and inserting taper pin in the air hole

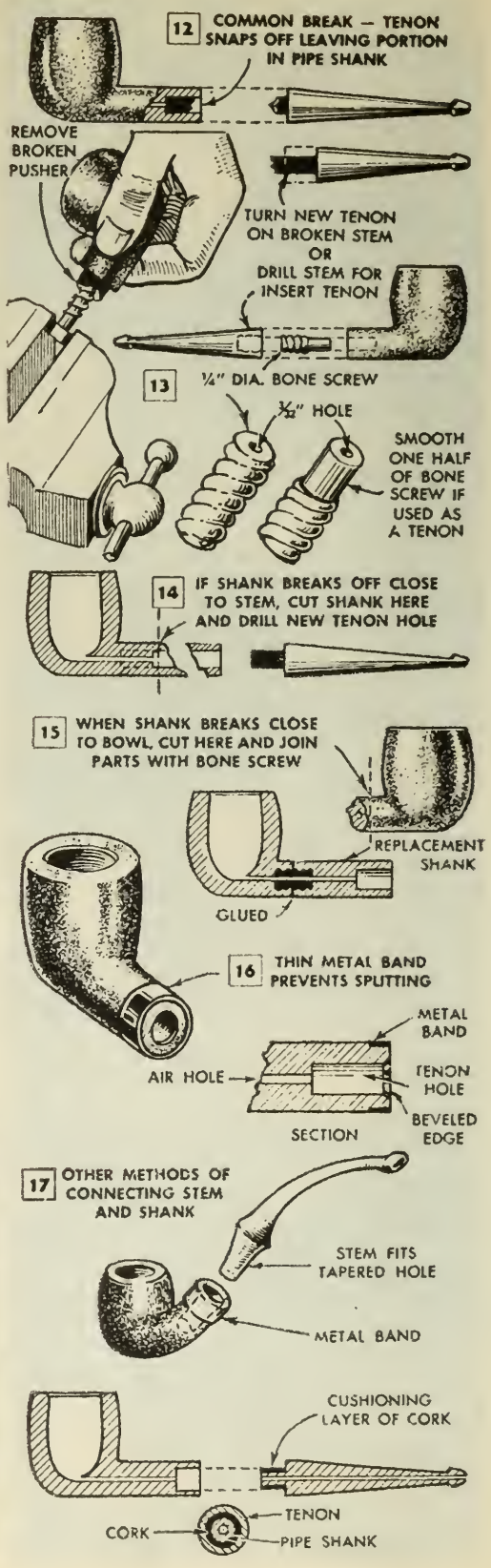


When the stem has been fitted to the shank, sand joint flush to assure a neat, close fit of these two parts

bring the parts of the joint flush. Then polish with oil and pumice. If care is taken in fitting the parts, the joint will be practically invisible. If the wood shows lighter at the joint (which it is likely to do on an old pipe) it can be brought back to the original color with a drop or two of stain. This is applied after finishing on the disk. Curved-stem pipes, Fig. 17, can be repaired in much the same way as a straight-stem pipe, provided the break is not too close to the bowl. In the former, the pusher hole must be taper-reamed. If the bit of a straight-stem pipe becomes unduly loose in the shank, the bit tenon is turned down slightly and fitted with a cork sleeve as in Fig. 17. The sleeves are available from dealers in pipes and accessories. Be careful when knocking out the ash to avoid striking the pipe against a hard surface. This may break the shank close to the bowl.

Keep pipes in a rack when not in use. As a rule, the type of rack which holds the pipe with the bowl down is considered best, although there is some difference of opinion among pipe smokers on this point.

If you break the shank of your favorite briar, it can be repaired by using a coarse-threaded bone screw



An Occasional Piece for Colonial Furnishings

STORAGE PLANTER

By John Bergen

USED AS A ROOM DIVIDER or merely placed against a wall, this attractive planter serves a dual purpose. Its greenery adds a charming touch to a colonial setting and its base provides a roomy storage compartment that can be put to good use in every home.

Where a low planter is preferred, the piece can be made without the trellis. You have a choice of several appropriate woods, namely, knotty pine, redwood and cypress. The material list below gives the sizes and number of pieces needed, all of which are stock lumber, and the pull-apart drawing on the following page shows clearly how the whole affair goes together.

Since the back will show when the planter is used as a room divider, construction details will vary somewhat in adding ¾-in. paneling all around. Also, all four corners of the base should be mitered and both front and back rails scrollsawed. Otherwise, construction remains unchanged. Start with the base. Notice in section details E

MATERIAL LIST

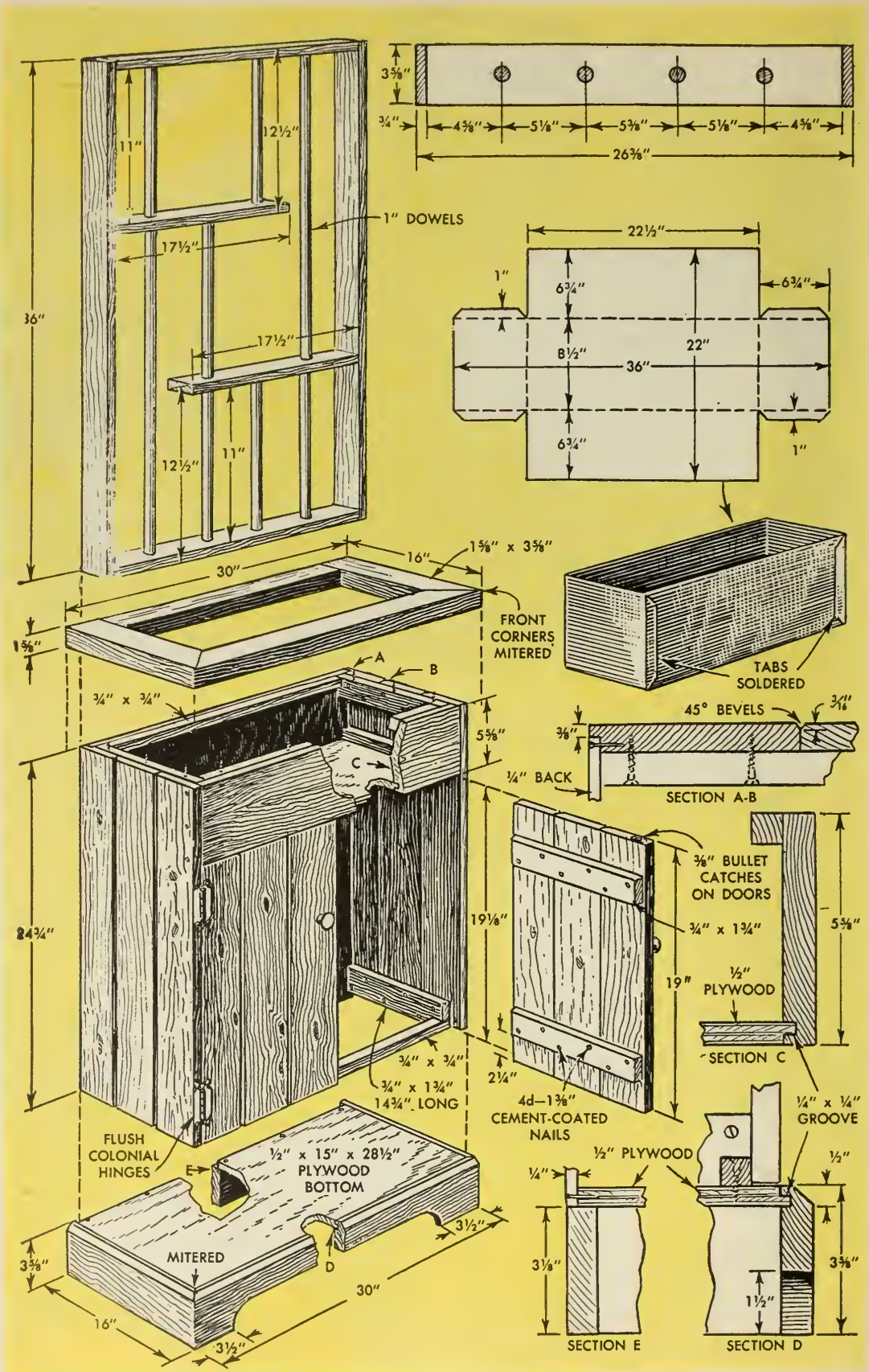
(KNOTTY PINE, REDWOOD OR CYPRESS)

BASE

2 pcs.—2 x 4 x 16 in.—Rim side rails
1 pc.—2 x 4 x 30 in.—Rim front rail
1 pc.—2 x 4 x 22¾ in.—Rim back rail
6 pcs.—1 x 6 x 24¾ in.—Side members
6 pcs.—1 x 6 x 19 in.—Door members
1 pc.—1 x 2 x 108 in.—Cleat material
1 pc.—¾ x 2¾ x 108 in.—Cleat material
1 pc.—¾ x 3⅛ x 28⅛ in.—Back base
1 pc.—¾ x 3⅝ x 30 in.—Front base
1 pc.—¾ x 3⅝ x 16 in.—Side bases
1 pc.—½ x 14 x 27 in.—Shelf (fir plywood)
1 pc.—½ x 15-3/16 x 28⅞ in.—Bottom
1 pc.—¼ x 27¾ x 25¼ in.—Back (hardboard)
4 flush-type colonial hinges
2 1¼-in.-dia. colonial knobs
2 ⅜-in.-dia. bullet catches with strikes
1 pc.—sheet metal 22 x 36 in.—Plant trough

TRELLIS

2 pcs.—1 x 4 x 36 in.—Ends
2 pcs.—1 x 4 x 24⅞ in.—Top and bottom
2 pcs.—1 x 4 x 17½ in.—Shelves
4 dowels—1-in.-dia. x 36 in. long


3⅝"
¾"
4⅜"
5⅛"
5⅜"
5⅛"
4⅜"
26⅜"
36"
11"
12½"
1" DOWELS
17½"
17½"
12½"
11"
22½"
1"
6¾"
6¾"
8½"
22"
36"
6¾"
1"
30"
16"
1⅝" x 3⅜"
FRONT CORNERS MITERED
1⅝"
TABS SOLDERED
A
B
¾" x ¾"
5⅝"
C
45° BEVELS
3/16"
⅜"
¼" BACK
SECTION A-B
24¾"
19⅛"
⅜" BULLET CATCHES ON DOORS
¾" x 1¾"
5⅜"
19"
½" PLYWOOD
SECTION C
¾" x ¾"
¾" x 1¾" 14¾" LONG
2¼"
4d—1⅜" CEMENT-COATED NAILS
FLUSH COLONIAL HINGES
E
½" x 15" x 28½" PLYWOOD BOTTOM
¼" x ¼" GROOVE
½" PLYWOOD
¼"
½"
3⅛"
3⅝"
MITERED
D
3½"
30"
16"
3½"
1½"
3¾"
SECTION E
SECTION D

and D that the plywood used for the top is fitted flush with the top edges of the side rails. Three edges are rabbeted to fit grooves in the inner faces of the rails, while the back edge is left square for nailing into the 3⅛-in. back rail. This forms a rabbet along the rear edge to house the ¼-in. back panel. The chamfered edge around the three sides of the base can be planed after assembly.

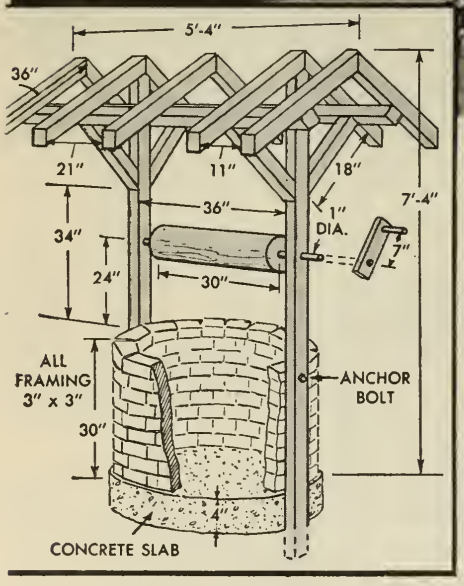
The pieces that make up the ends of the storage compartment are made into 15¼-in. panels by screwing them to cleats placed at top and bottom. The cleats are made 1 in. shorter than the width of the built-up ends to allow for the thickness of the back and the doors. Note in section detail A-B that a rabbet is cut along the rear edge of each end panel and that a V-joint is formed between the individual boards by prechamfering the meeting edges slightly.

Toe-hole cutout in base apron is quickly cut with bandsaw. Both front and back aprons should be similarly cut when planter is room divider

The trough compartment is formed by gluing and nailing the built-up ends to an L-shape assembly made up of a front board and a bottom board, joined in the manner shown in detail C. A ¾-in.-sq. cleat at each end provides support for the bottom board. Similar cleats along the front and back at the top take the screws that anchor the rim. The latter is made as a separate frame from 2 x 4 material. If the planter is to be used as a room divider, all four corners of the rim should be mitered to look best. Otherwise, the rear corners need only be butted. Dowels or splines at the mitered joints make the best construction, but an easier way is to simply glue and nail them and later conceal the nailheads with wood putty. The rim is placed flush at the back and centered so it overhangs ¾ in. at the sides and front. Glue it in place first and then drive the screws up through the cleats in predrilled holes. A short stubby screwdriver will do best here. As a room divider it might look better to let the rim overhang all around in which case the width of the rim frame should be increased to 16¾ in. The doors are made up in the same manner as the ends, chamfering the edges of random pieces to produce V-joints and gluing and screwing them to cleats placed across the back. If you don't care to make the sheet-metal liner yourself, take the pattern given to your local tin shop. If you make it yourself, buy a sheet of 22-gauge metal and cut it just like the pattern. By clamping a board 8½ in. wide and 36 in. long to the middle of the sheet metal, you can do a neat job of bending up the sides and tabs. You'll have no trouble in bending the ends inward. Notice that the tabs are on the outside.

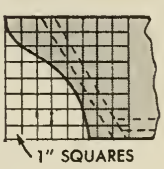
The base is attached to the upper part of the planter by driving screws up through the plywood top and into the end cleats. Additional rigidity is gained in nailing the back panel in the rabbet at the back. A ¾-in.-sq. cleat is fitted across the front to provide a ledge strip for the doors. If you wish, shelves can be added to the storage compartment. In doing so, cleats should be first screwed to the ends to support the shelves. They can be left loose or glued.

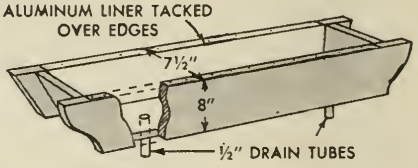
The trellis section is a simple affair that is made from 1 x 4 material and 1-in. dowels. To assure perfectly aligned holes in the four cross pieces for the dowel uprights, stack the pieces in their respective positions, clamp, and drill through the four members at one time. By drilling through from the bottom, you can easily make blind holes in the members the dowels do not pass through. The dowels are locked in place by cross nailing, and the butted corners of the frame are merely glued and nailed. A couple of roundheaded screws will hold the trellis to the rim of the planter, flush with the back. ★ ★ ★



PLANTERS SET THE SCENE

ONE CAN USE outdoor planters to key the planning of nearly all outdoor-living areas. As an example, note how the replica above, Fig 1, not only is a decorative planter in itself, but also is, architecturally, a part of the house. Materials and finish have been selected to achieve this end. The covered well is made of used brick and is covered by a shale roof. Framing is of 3 x 3-in.





2. The planter shown at the right is a simple redwood box lined with sheet aluminum and has a ½-in. tube near each end for drainage. It may be supported by shelf brackets or screwed to a window sill

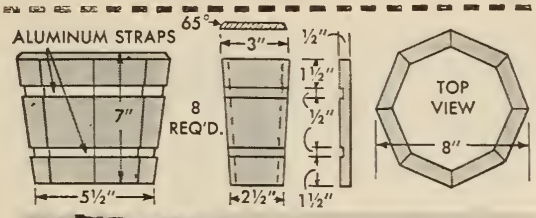
4. A simple shelf like this one may be decorated with a valance. The cedar "buckets" are cut, assembled with glue and then bound with aluminum bands

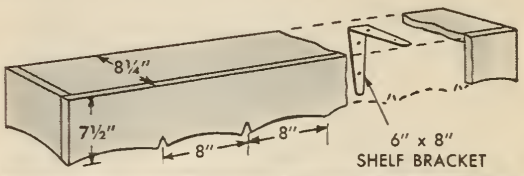
5. This planter is made of cypress which properly finished will well stand dampness and inclement weather. If made of pine, planters such as this should be lined with sheet metal or with tar

Flanking the entrance walk, planters such as this one add color and atmosphere to the house and grounds

redwood uprights secured with bolts and set below grade to a depth of about 1 ft. For strength, the unit is erected on a 4-in. concrete slab with the brickwork laid in after the uprights are installed.

The number of designs used to make outdoor planters is limited only by the imagination and resources available to the designer. The size and shape of the lawn or garden area will, of course, largely determine the limits of what can be done. But once the practical possibilities have been assessed, imagination may be given free rein. If planters are used to divide an area, for example, the beginning of a geometrical motif is set, and a judicious use of smaller





Cut flagstone has the advantage of being both pleasing to the eye and easy to manage in construction. This planter is made of layers of flagstone and has a grillwork of iron pipes supporting a wooden roof

Here, blocks of limestone were used to enclose a flower bed near the entrance of the house. Level with the surface of the porch, the planter becomes, in effect, an extension of the house itself

planters, flower beds and shrubbery, Figs. 7 and 9, may be used to further develop it. The use of wood and stone in a rather large planter may set the accent which the rest of the ground design repeats and develops. The use of plants also offers many possibilities. For instance, climbing vines and flowers in a central planter which has a trellis may be set midway between the house and the fence or walk. This may then be repeated in shallow planters bordering the area and by ivy climbing the house itself. Stone planters extending perpendicularly from the house midway into the lawn area, as in Fig. 3. match the masonry construction of the house walls, which may again be repeated in stone-bordered flower beds flanking the house on two sides and along the front. The planter shown above is a good example of the rugged beauty of stone and of the use to which it can be put. It is made of cliff stones of various sizes and the spreading rock plants will eventually cover it. The contrast of leaf and stone will only serve to enhance its beauty. If desired. such planters may be made to extend the entire width of a lawn and thus serve as rustic stone fences. The

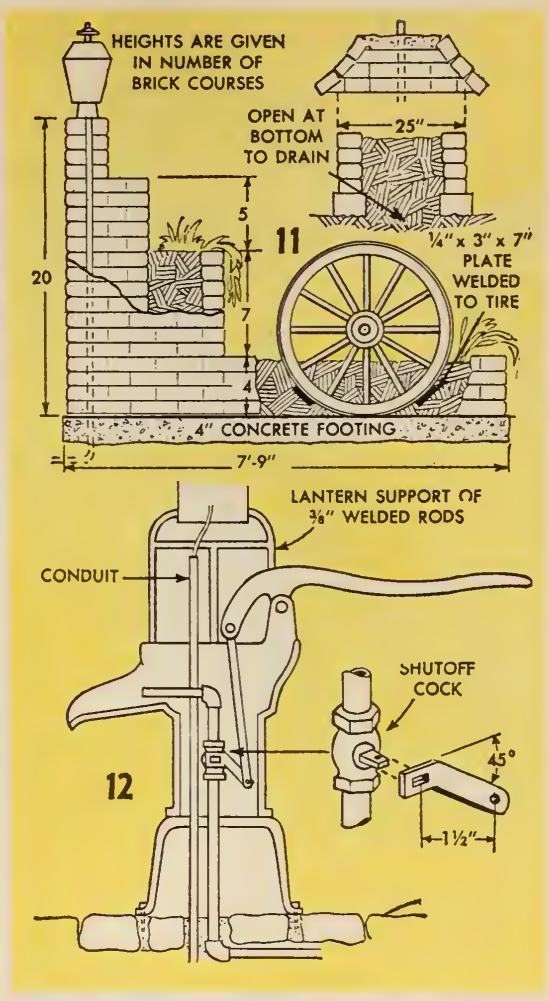
Wagon wheels add a picturesque quality to any lawn. This one was set in a shallow planter and is backed by a pedestal topped by a lamp. The planter is open at the bottom for drainage of the lush English ivy

Almost austere in its formality, this stone planter is set with a sword palm near the entrance of the house. Several of these placed on a concrete patio or veranda add an air of dignity to their surroundings

Homeowners in the dry Southwest will appreciate the decorative grace of these sand-filled cactus planters. They are made of cultivator disks welded to pipe flanges and set on pipes driven into the ground

planter in the photograph has a lamp and a bench running along one side.

Various objects, such as wagon wheels, or hand pumps, Figs. 8 and 11, serve to add a certain flavor to a garden's semiformal arrangement. This motif may be extended to replicas of the old oaken bucket set on window shelves, Figs. 2, 4 and 5, or to an open-"well" planter. For more sophisticated decoration, a patio may be decorated with individual "gardens," Fig. 10, or divided from the rest of the garden by brick planters with uprights extending to the patio roof as shown in Fig. 6. ★ ★ ★



A combination of concrete and colored pebbles forms the dish top of this striking patio planter

Novel arrangement combines a means of watering plants and illuminating the lawn. A ½-in. pipe through the masonry has shutoff valve connected to the pump handle. Lamp is switched on from the house

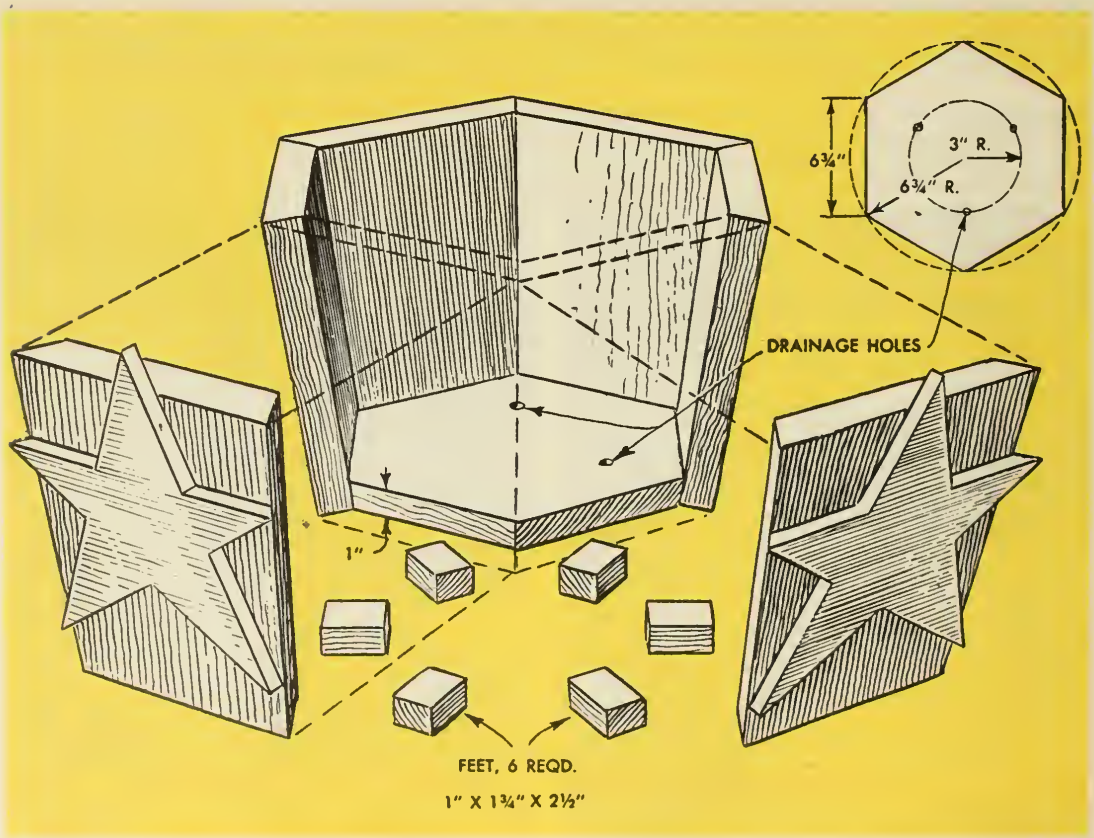
ATTRACTIVE PLANTING BOXES
for Your Indoor Garden

By C. W. Woodson

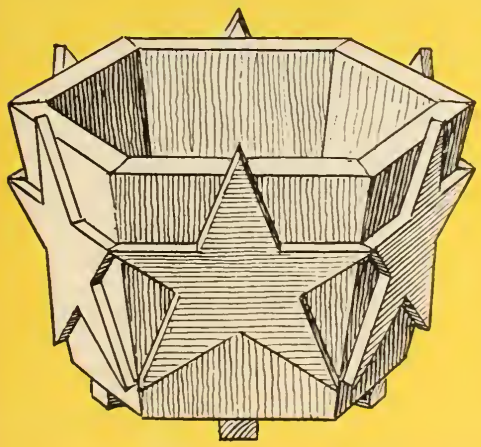
LIVING INDOOR GREENERY can be yours the year 'round with a little careful planning. And by using these planting boxes you can change room decor, plants can be moved about to create attractive color effects. As an example, a live evergreen can serve as a room divider in summer and as a living Christmas tree during the holiday season. The secret of this changeability is the use of the planting boxes and balled specimens rather than making permanent plantings indoors. Balled evergreens in the medium and narrow pyramidal forms, also many other low-growing shrubs, can be made to thrive indoors wherever light, temperature and humidity can be closely controlled. Usually it is possible to meet these conditions in both old and new homes. During the warmer months the larger plants and shrubs can be moved outdoors and utilized as portable decorative features of the permanent outdoor-garden plantings.

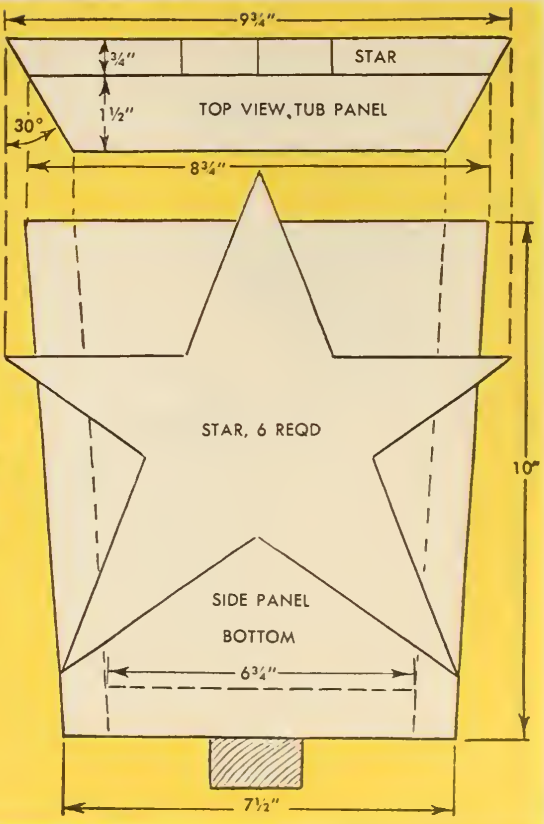
To assure long life, use redwood or cypress for planting boxes. Coat the interior with hot asphalt, or line with sheet copper, all joints being soldered. Drain holes in the bottom of the box are protected by extending short lengths of tubing through them, and soldering to the liner.

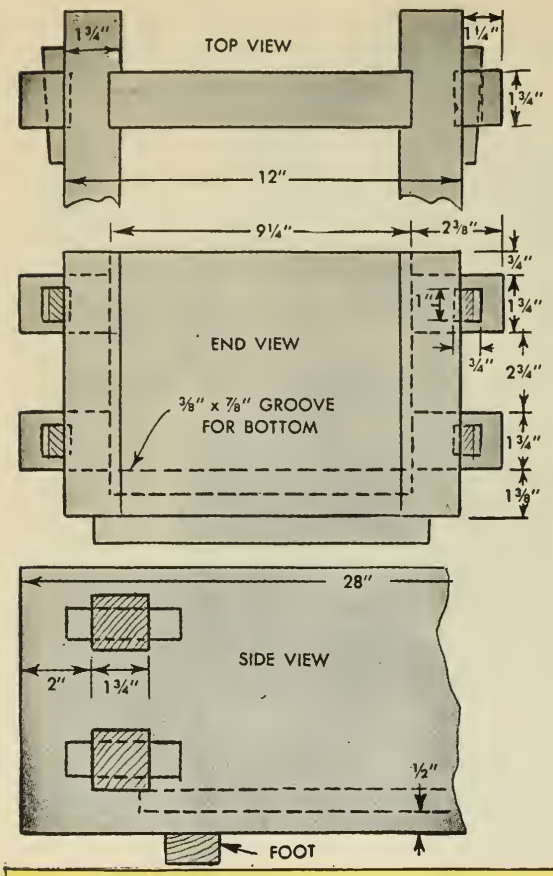
On these two pages are shown detailed drawings of a planting box that is suitable for a living Christmas tree. Stock for the sides is 1½-in. material, the bottom is 1-in. stock. The bottom is drawn by scribing a hexagon inside a circle. The radius of the circle is 6¾ in., which is within a fraction of an inch of being equal to the side of the inscribed hexagon. A slight adjustment of a compass will produce six equal divisions on the circle, to provide six sides for a hexagon. The stars for the planting box are cut from ¾-in. stock and are attached after the box is assembled with glue and screws. This particular container may be painted in bright colors in keeping with the holiday spirit, as it is used generally for a decorated Christmas tree.



All plant boxes should be raised slightly by the addition of feet so air can circulate beneath and keep bottom dry. Also, all should have drainage holes bored in the bottom to allow excess water to escape. Pieces of broken pottery may be placed over the holes. Copper liners can be fitted to all boxes if you wish



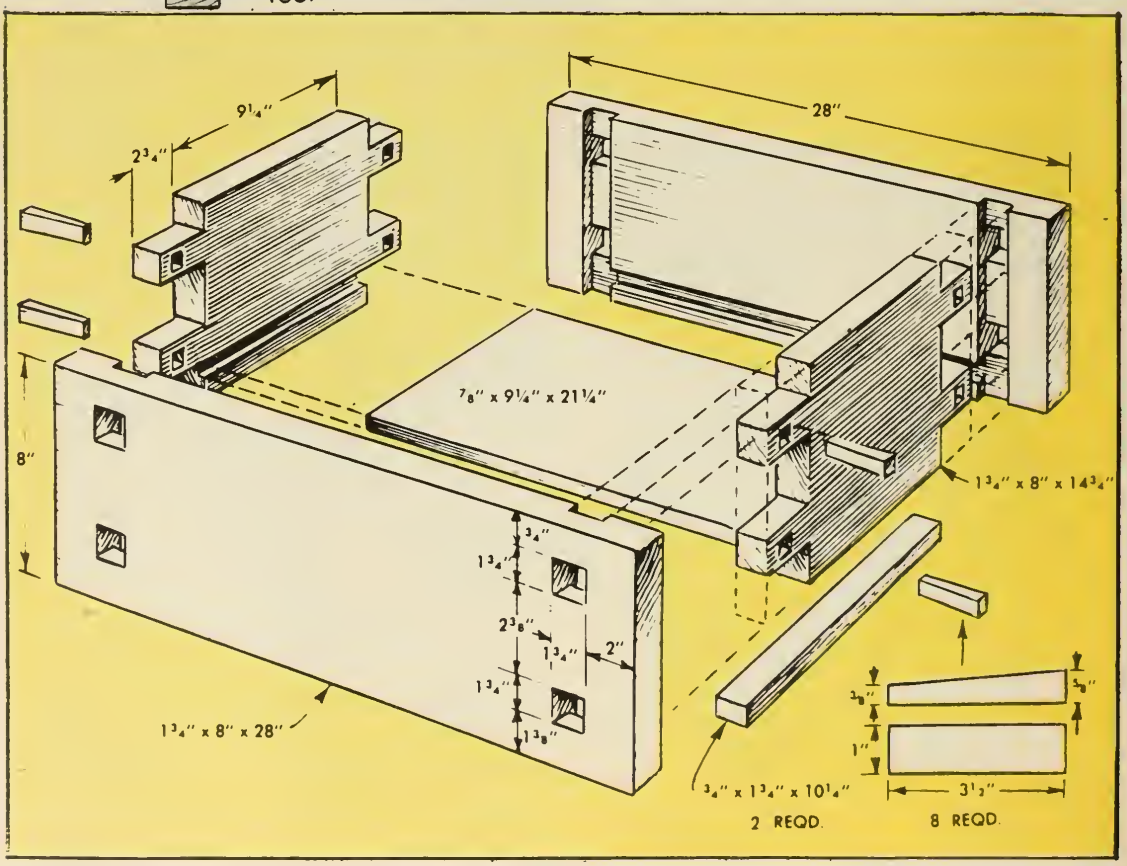




On this page are shown the details of a rectangular planting box of more modern design. Despite its modernity, no nails or screws are used in its assembly. Instead, the ancient method of using wedge-shaped pegs is employed. A mortising bit and a drill press are handy in making the cutouts in the construction of this planting box, but a careful craftsman can use a regular wood bit and a wood chisel to obtain excellent fits between the various components. The sides of this box are cut from 1¾-in. stock, the bottom from ⅞-in. material.

Feet for this planting box are strips of wood. Some sort of feet or spacers are needed under all planting boxes that are portable, to allow for drainage and to assure circulation of air under a box. This will prevent any moisture that collects on the outside of the box from remaining long, and causing rot or mildew. A situation that might cause water to collect on the bottom of a planting box would be an overwatering which would cause water to run out the drain holes in the bottom of the box, and collect on the bottom. Such moisture might encourage the growth of harmful bacteria or fungi, that would produce a root-destroying disease in the soil.

On page 1643 is shown a square planting box that is ideal for small evergreens and ornamental shrubs. If you have ever



wished you could occasionally change the character or appearance of your terrace by moving the planting to different locations, this container will permit you to satisfy that whim. Some plants that die out in the fall can be kept in bloom almost all year 'round if they are moved indoors before frost occurs. Planting boxes of varying sizes built in the same proportions and design as the one on this page will permit various kinds of shrubs and plants to be moved indoors to beautify your home during the long winter months.

Miniature rosebushes that bloom all year 'round, as well as dwarf fruit trees now are available, and would fit easily into any of the several planting boxes described in this article. Also, you might have a spot in your living room that would require a planting box of a special shape to fit properly. Build it in that space and bring summertime outdoor beauty into your home. It will be easier to forget the cold and blowing snow outside with green, blossoming shrubs inside your living room.

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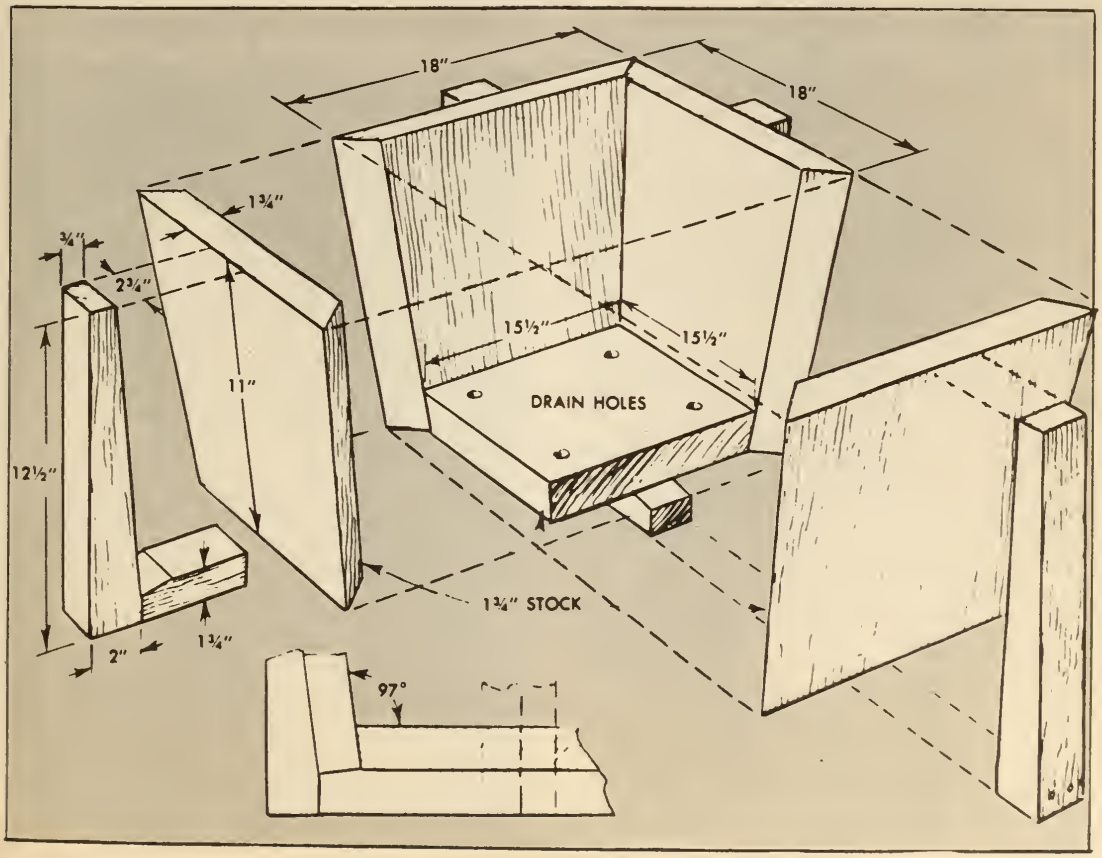
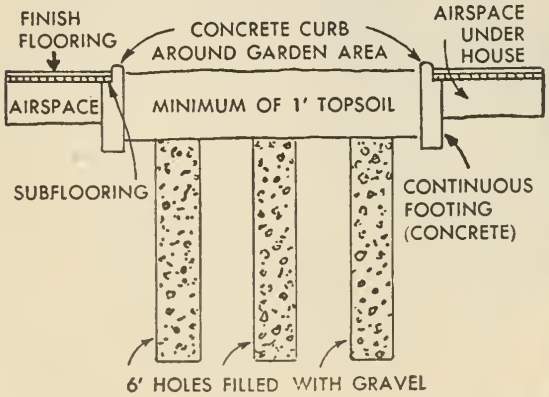


Skylights in ceiling provide adequate source of natural light for this garden planted beside a room divider

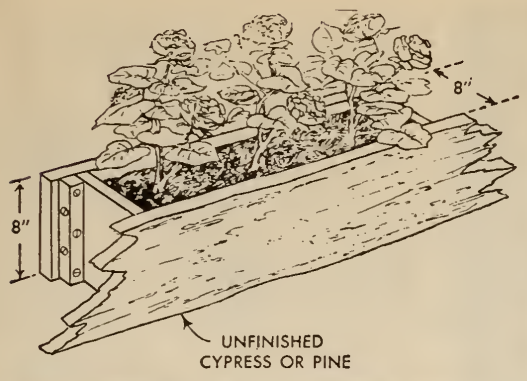
Bring Your Garden Indoors

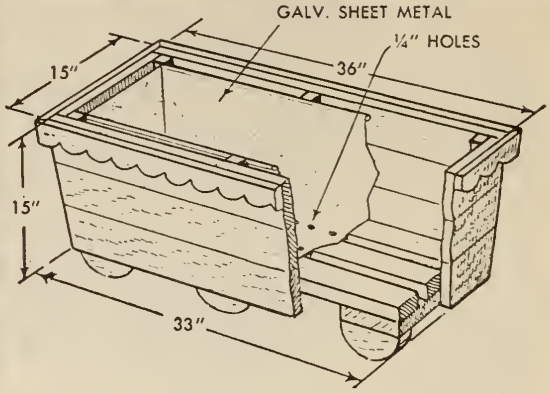
PLANTS, whether big tropical varieties or small succulents, add a dramatic touch to the interior of any home. And modern building ideas make it easier to have an outdoor-size garden in your living room the year around. Skylights, for example, can provide enough sunlight to grow many kinds of plants along an inside wall or a room divider. And large windows near an outside door will sustain an attractive entryway garden.

In basementless homes an indoor garden can be built directly upon soil beneath the floor, as shown below



Indoor garden also can be located near the front door. The light source here is an entryway window

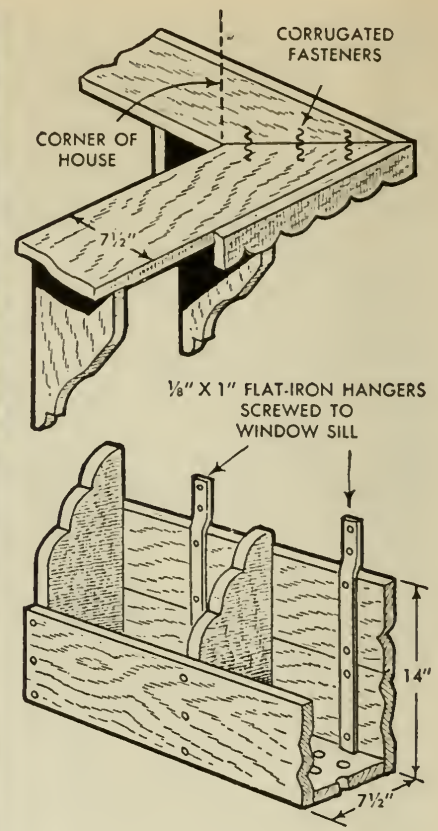




WINDOW BOXES

HANGING gardens placed at the window-sill level are of immense decorative value to both the interior and exterior of any home. Foliage and flowering plants, certain dwarf shrubs, evergreens, potted slips, succulents, and even trailing vines can be grown in a window-sill garden and they will thrive with a minimum of care. Some varieties grow best in full sunlight; others do well in partial shade, and some in full shade. This means that, by carefully selecting the plants, you can grow luxuriant hanging gardens on all four sides of the house in a single season. Groups of plants selected for a given location should have the same or similar soil preferences, and also similar temperature and sunlight requirements. Only low-growing plants with heavy stems and short foliage should be selected for second-floor window gardens, as these will be more directly exposed to high winds and beating rains. If shelves are used at the second-story windows, holes should be scrollsawed in the shelf boards so that the plant pots can be set in the holes to about half their depth. This arrangement prevents the potted plants from being blown off the shelves. If soil is to be placed directly in the box, the latter should be made of wood with a removable metal lining of zinc or aluminum. Cypress is the most durable wood, with redwood and pine a second choice. The selection and preparation of soils are important. As the amount of soil is limited by the size of the box, the plant food of an ordinary soil will soon be depleted. A good mixture for window boxes is composed of dark garden loam, rotted leaf mold and sand in the proportions of 2 parts loam, 1 part leaf mold and 1 part sand. After these components are mixed, a complete fertilizer is added. Then the whole mass is mixed thoroughly and sifted through a ½-in.-mesh screen. To grow most varieties of succulents, proportions of the soil mixture should be 2 parts loam to 1 part coarse sand, no leaf mold being used.

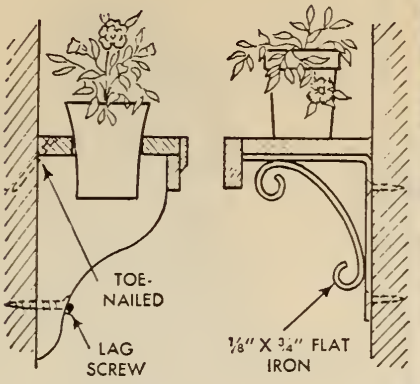
In preparing the window box for planting, ½-in. drainage holes are drilled in the bottom in an over-all pattern measuring about 3 in. each way. Small pieces of

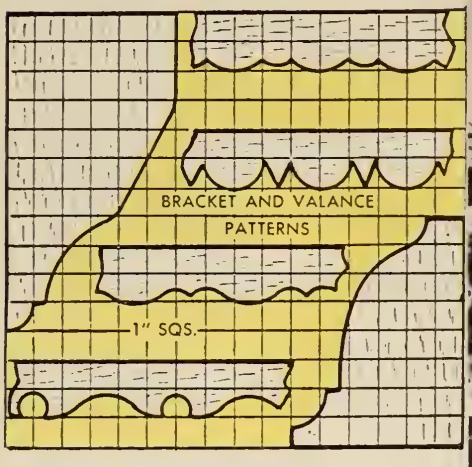


broken pottery (pieces from a flowerpot will do) are placed over each of the holes to keep fine material from sifting through. Then a 1-in. layer of coarse gravel, cinders or small pieces of broken pottery is placed in the bottom of the box. If the box is to be planted with succulents, the layer of this material should be 2 in. thick. Fill the box with the soil mixture to within about ½ in. of the top, pressing it down firmly. The mixture should be dry enough to handle easily without sticking to the fingers.

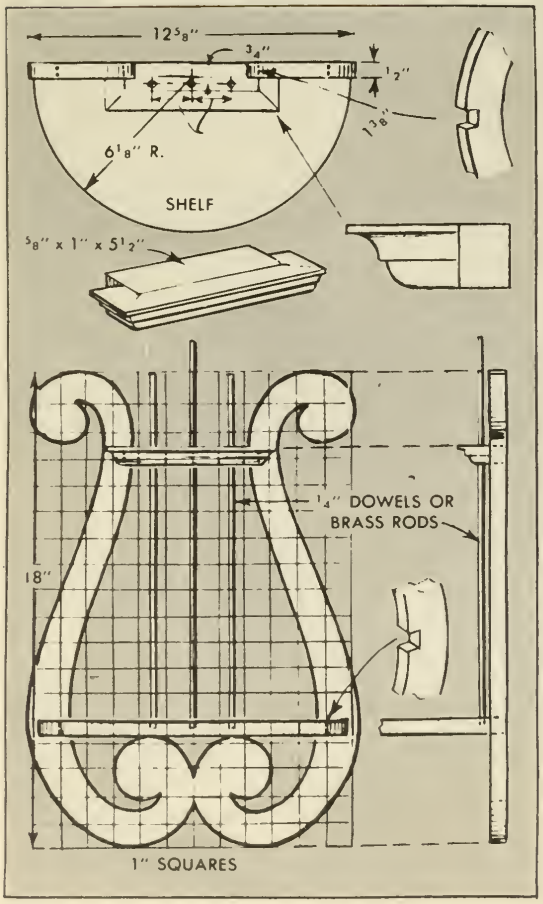
Plants to be grown in such a confined space as the average window box should be selected for type and habits of growth. Foliage plants with large individual leaves should not be planted adjacent to small, low-growing plants, except in extra-long boxes where the large plants can be placed at the ends of the box or in the center. If planted at random or alternately in a smaller box, the large leaves of the taller foliage plant will shade the smaller plants during some part of the day and may thus affect the rate and extent of growth. As a result of spreading root systems, large and vigorous growers also will rob small plants of needed soil fertility. Window-box gardeners generally select low-growing flowering plants for the sunny side, foliage plants and trailing vines for the areas of partial and full shade and small evergreens for the year-round window garden. Suitable evergreens may be any of the low, spreading varieties which grow slowly. Certain plants that will not mature fully in the shorter growing seasons of the colder regions are suitable for outside plantings only in the warmer climates.

Most window-box plantings must be sprayed or dusted regularly to keep off insects and prevent disease. Spray solutions can be applied with a syringe, and prepared dusts with an applicator usually furnished with the product. As a rule, only annuals are planted in outside window boxes in temperate regions. In most cases, potted plants placed in or on window boxes or shelves are taken inside during the colder months. This simplifies the insect and disease-control problem, at least to some extent. Plantings of evergreens that are well established will flourish the year 'round in exposed locations if they are properly cared for during the summer and are thoroughly watered just before the coming of freezing temperatures. At this time, a thorough watering is especially important for if the soil freezes "dry" the plants are likely to die.





Window boxes and shelves pictured and detailed in Figs. 1 to 5 inclusive are designed for mounting outside the window. Those shown in Figs. 6, 7 and 8 are built as a part of the house and, in the warmer climates, can be used for plantings of perennials. Shelves are supported on bandsawed brackets and decorated with an edging or valance in a scrolled design as shown on the corner shelf in Fig. 3. Several scroll-sawed designs for brackets and edgings are shown in the crosshatched detail above. The shelf in Fig. 5 is supported by flat-iron scrolls which are especially attractive when used on walls of white siding or stucco. When shelves are attached to the wall with brackets, the inner edge should be set out from the wall about ¼ to ½ in. so that water and dirt do not collect at this point. Use brass screws for fastening the brackets to wooden walls and masonry drive nails or expanding fasteners on masonry walls. In either case, the fastenings should be sufficiently strong to support the weight of the box when it is full of damp soil.



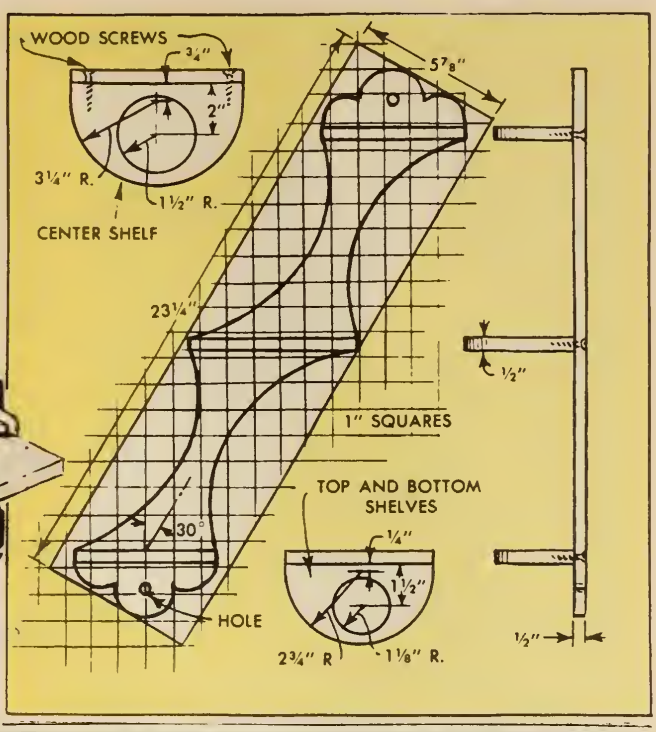
FOUR WALL PLANTERS

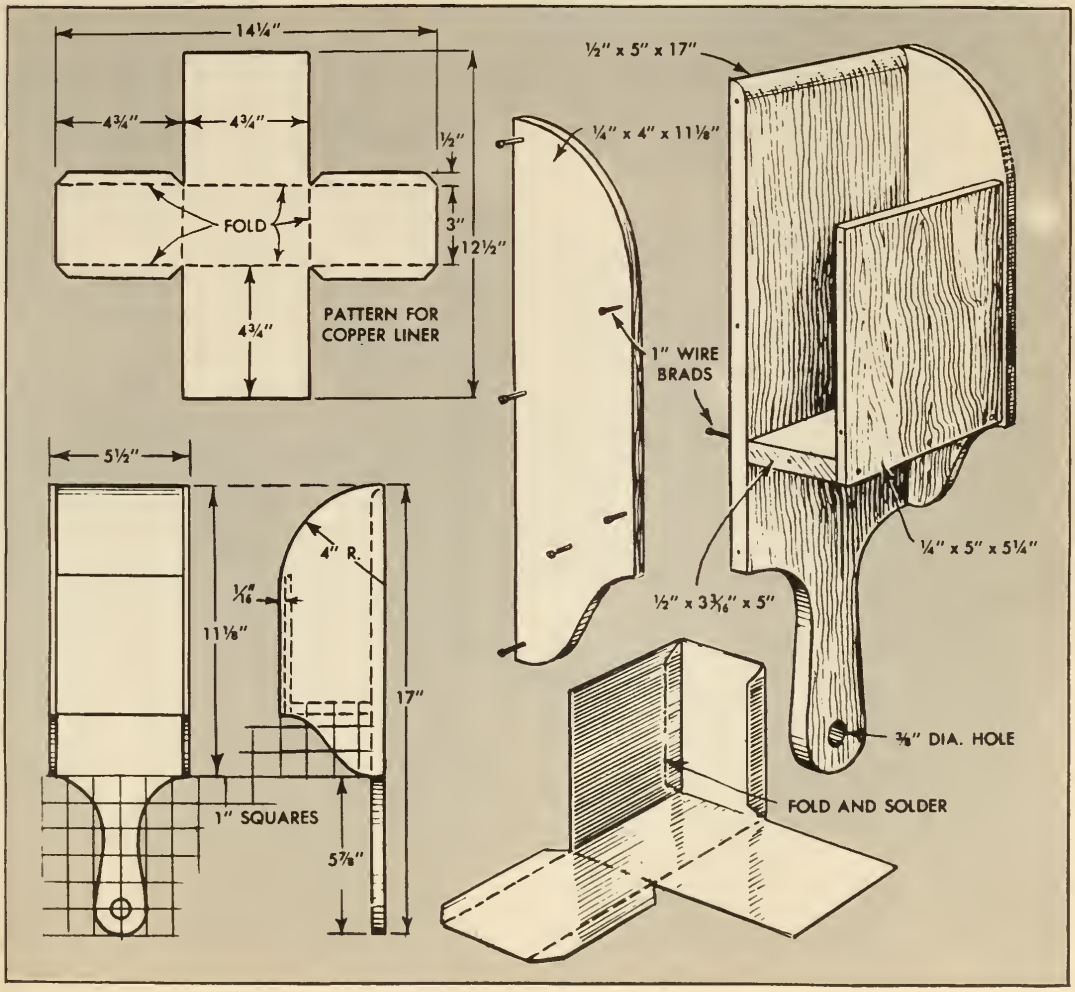
for attractive display of your plants

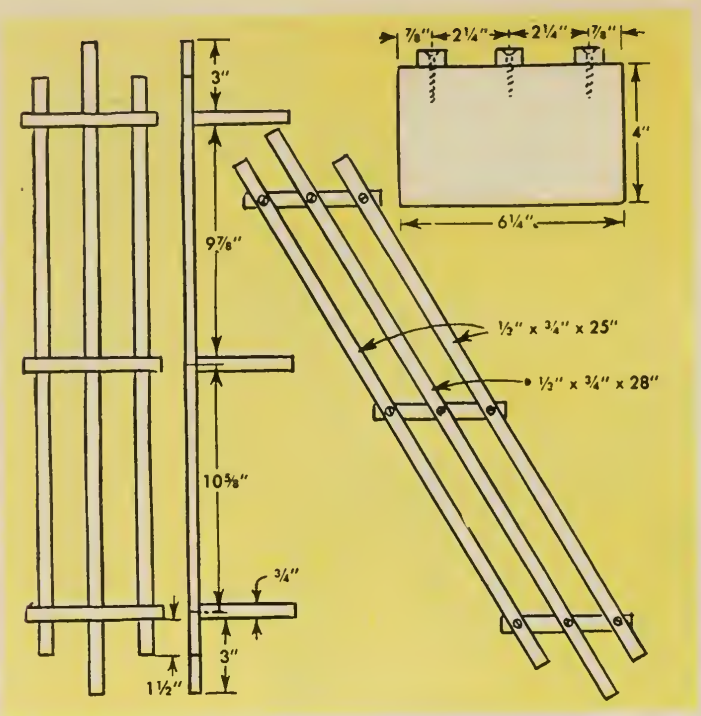
POTTED PLANTS grown indoors always are more attractive and more easily tended when they have their own special racks or shelves. And whether your taste and decor run to colonial, modern, classic or conventional, you will find a style of shelf or rack described in this article that will meet your needs. As with any job, power tools will reduce both the time and labor required to make the plant holders, but hand tools are entirely adequate.

Classic Lyre

The classic lyre shape of the shelf detailed on this page can be jigsawed from a single piece of plywood or cut from two pieces of solid stock. In the latter case, one half of the pattern is drawn on one piece of stock, which is placed over another and both pieces are jigsawed at one time. A dowel glued and fitted in blind holes at the point where the side scrolls join will hold the lyre together at the lower end, and the decorative cross piece near the top will hold the upper ends of the lyre in position. Adding the shelf and the vertical members, which can be ¼-in. dowels or brass rods, will give rigidity and strength to the


WOOD SCREWS
¾"
2"
3¼" R.
1½" R.
CENTER SHELF
5⅞"
23¼"
½"
1" SQUARES
TOP AND BOTTOM SHELVES
¼"
1½"
30°
HOLE
2¾" R.
1⅛" R.
½"


14¼"
4¾"
4¾"
½"
FOLD
3"
12½"
4¾"
PATTERN FOR COPPER LINER
½" x 5" x 17"
¼" x 4" x 11⅛"
1" WIRE BRADS
¼" x 5" x 5¼"
½" x 3⅜" x 5"
⅜" DIA. HOLE
FOLD AND SOLDER
5½"
4" R.
1/16"
11⅛"
17"
1" SQUARES
5⅞"



finished shelf. Note that inside edges of the lyre scrolls are notched to accept the shelf and top cross piece, which adds both strength and neater appearance to the finished assembly.

Modern Design

Modern design is featured in the next shelf, which actually consists of three brackets arranged in steps. A hole is bored in each shelf to accommodate flowerpots, as indicated. The top and bottom shelves have a 2¼-in.-dia. hole, the center shelf has a 3-in.-dia. hole, so that the larger pot is located on the center shelf.

Again either plywood or solid stock can be used. If solid stock is used, a 2-ft. length of ½ x 6 is adequate for the back piece. For greater strength, 1-in. stock could be used. The three bracket shelves are butted against the back piece and fastened with glue and wood screws.

Early American or Colonial

Maple furniture and shining brass provide the decor which goes best with the "flour scoop" planter, but it will look well even in a modern kitchen. Extremely simple in design, only a few curves are required and these are shown on a pattern of 1-in. squares. The curves can be varied from the original for individuality, and both sides of the paddle-shaped back of the planter made identical by first drawing one half of the pattern on a folded sheet of paper and cutting it out to form a full pattern. The unfolded pattern then can be traced on the stock with a pencil. The two curved sides of the scoop are clamped or nailed together temporarily and jigsawed at one time, to assure that they are the same size and shape. The scoop is designed to have flowers planted directly in it without need for a flowerpot, so a waterproof liner is required. Copper is the best metal to use for the liner, as it is bent easily as well as being rust-resistant. However, both brass and galvanized steel also can be used. Cut out the liner according to the detail, fold as indicated and solder it. The wooden portion of the planter may be made of maple, or pine can be used and stained maple. To blend with more modern decor, the planter might be enameled and a decal added for the final touch. Two holes must be drilled near the upper edge of the planter back to permit hanging or fastening it to the wall. They are not shown on the detail. The ⅜-in. hole in the handle is a touch of realism, but can be used to screw the handle to the wall, if that is necessary.

Trellis-Type Shelf

The last shelf is of more conventional design and is simple to make. It consists of two 25-in. lengths of ½ x ¾-in. stock and one 28-in. length of the same material, that are used to form a vertical trellis to which three shelves are screwed. To provide an alternate design, the screws may be loosened and the back tipped at an angle, as indicated. ★ ★ ★

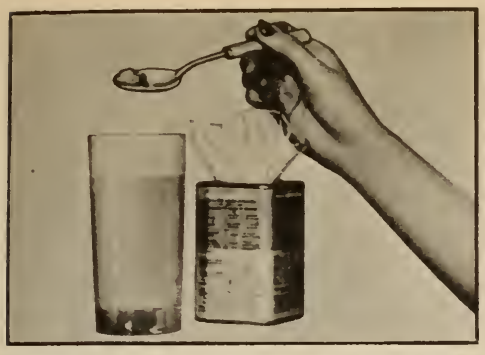


Fig. 2. Mixture of plant food and water is prepared for plants to promote normal growth in your absence

Save Your Plants While on Vacation

HOUSE PLANTS can't be taken along when you go on an extended trip. However, you can be assured that they will not only survive but remain in good condition during your absence, if given special attention before leaving as illustrated.

Remember that plants need fresh air just as much as they need water. Don't try to prevent evaporation of a plant's water supply by covering it with a glass enclosure as in Fig. 1. The plant will die for lack of air. If you have a terrarium, do not give it an oversupply of water since it has no provision for drainage, Fig. 6.

Fig. 1. An enclosure should never be placed over potted plant to reduce moisture evaporation. The plant would then be deprived of fresh air which is required for its survival and healthy growth

Fig. 4. Give plants their usual dose of supplementary food but no more than is required for one application

Fig. 3, below. Since most plants are accustomed to daily exposure to sunlight to carry on photosynthesis, remember to leave blinds partly open so as not to deprive them of this important requirement

Fig. 5. Philodendron leaves are cleaned with wet, lintfree cloth to permit plant to "breathe" properly

Fig. 6. Since terrarium has no drainage facility, water is sparingly applied to avoid decay of plants

There are several ways of cleaning plant leaves, the easiest being simply to sprinkle a small amount of water on them with a rubber-bulb sprayer as in Fig. 7. Large leaves can be cleaned with a wet, lintfree cloth, Fig. 5.

A good way of reducing moisture evaporation from a potted plant, is to soak the soil and then insert a heavy cardboard disk in the top of the pot to fit around the stem or stems of the plant. For an absence of more than a week in hot weather, it is best to arrange to have your plants watered at least once a week. ★ ★ ★

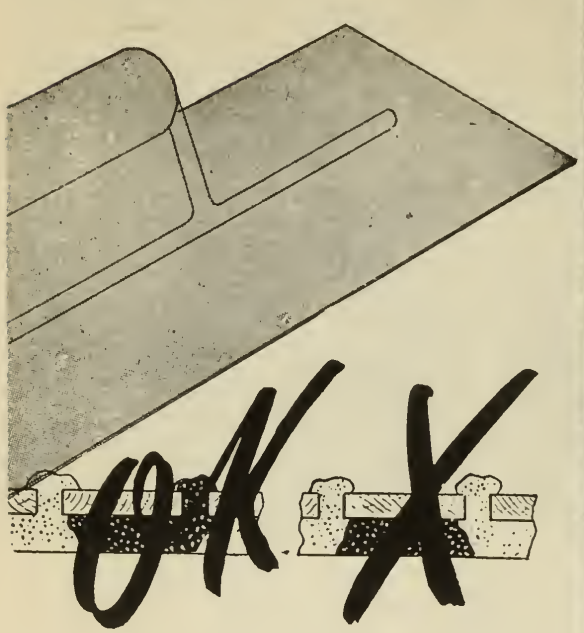
Fig. 7. Rubber-bulb sprayer is ideal for washing dust from plant so that leaves "perspire" properly

PLASTER PATCHING

IT'S NO JOB at all to make minor plaster repairs such as filling cracks, "spotting" nail holes and sealing spaces between wood trim and plaster. Equally important is the occasional job of replacing loose plaster, especially in older houses. The time to make these repairs is just before repainting or wallpapering. Many remodeling jobs also require some plastering, which the average homeowner can tackle. However, major replastering jobs such as entire walls and ceilings call for the skill and experience of a professional plasterer.

Where to use Spackling putty: You use Spackling putty to fill cracks in plaster, from hairline size up to about ⅛ in. wide; in nail and screw holes around which plaster has not broken away; for nicks and surface imperfections in plaster, and for cracks that have developed between wood trim and plaster. To use the putty, first remove grease with strong washing solution and clean off all loose paint and dirt particles. A putty knife or wide scraper is handy for applying it and to smooth it on flat surfaces. At corners you can use a spear-shaped window-glazing tool, or just your finger protected with a rubber finger cot. Wipe off excess putty and smooth down the filling with a wet sponge.

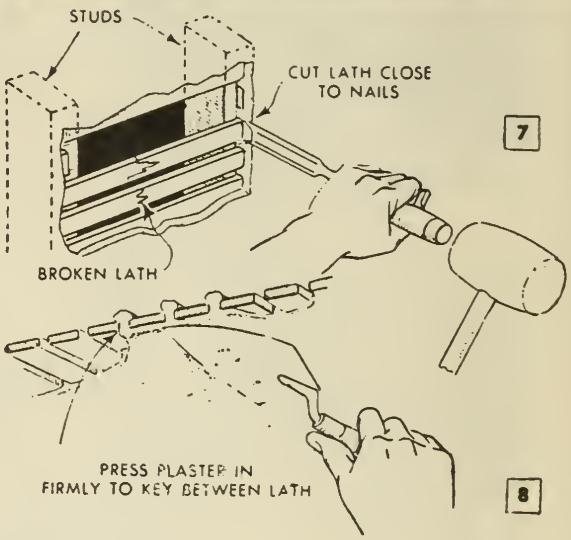
Patching plaster: For cracks over ⅛ in. wide, and for areas up to about a foot or so square, use patching plaster. The powder is prepared by adding water and mixing to a smooth paste. Don't mix more than you can use before it starts to set—from 10 to 30 minutes depending on the product. Setting can be retarded by adding an equal amount of vinegar to the water used for mixing. Undercut the edges of cracks and small patches to make them wider at the bottom than at the top as in Fig. 1. This anchors the plaster in place. Next, brush away all loose particles and soak the old plaster, and plaster base if exposed, with water, Fig. 2, using a brush. Try to avoid



runs that may stain wallpaper. Wetting prevents rapid absorption of moisture from the patching plaster, which causes it to dry out too fast and crack away at the joints.

Press the plaster firmly against the under edges with the putty knife, Fig. 3. If the hole goes down to the lath, press the plaster down to key with the lath. Fill the hole, or wide crack, to ⅛ in. below the surrounding surface. If the hole is filled flush in one application, shrinkage of some kinds of patching plaster may cause a dish-shaped depression. Let the first application dry overnight, then wet the surface and complete the job, Fig. 4. If a nonshrinking type of plaster is used, fill the hole in one application. If the patch is too high when dry, dress it down with a coarse file (handle removed) or with sandpaper wrapped around a small block, Fig. 5. Seal the patch with thin shellac and allow this to dry before painting to prevent its showing up as a dull spot. If the adjoining wall surface has a sand-float finish, make the patch finish similar by adding an equal amount of clean, sharp sand to the last application, and pounce it with a piece of pile carpeting wrapped around a block.

Larger patches: When plaster bulges, particularly on ceilings where wood lath is used, and especially if it has been subjected to repeated soaking, chances are that it has loosened from the lath and is likely to fall off. Then the only remedy is removal of all loose plaster as in Fig. 6. Old plaster keys between the laths are pushed through, out of the way, so that the new plaster can key securely. Make the edges



of solid plaster as regular in shape as possible—without jagged edges.

Sometimes the laths are loose; if so, nail them down solidly to joists or studs with lathing nails. If a lath has been pulled off, replace it. Broken laths are more likely to occur in walls crushed by heavy impact. In such cases the plaster is removed back to a stud on either side of the break and the broken pieces of lath are cut off midway on the studs with a chisel and mallet as in Fig. 7. This provides space to nail on new pieces of lath. Spacing between wood lath

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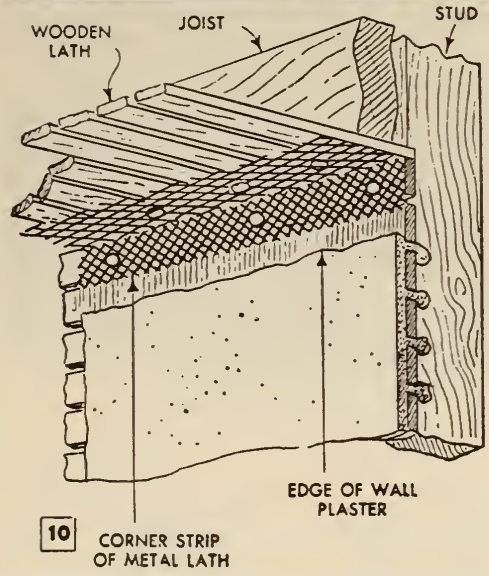

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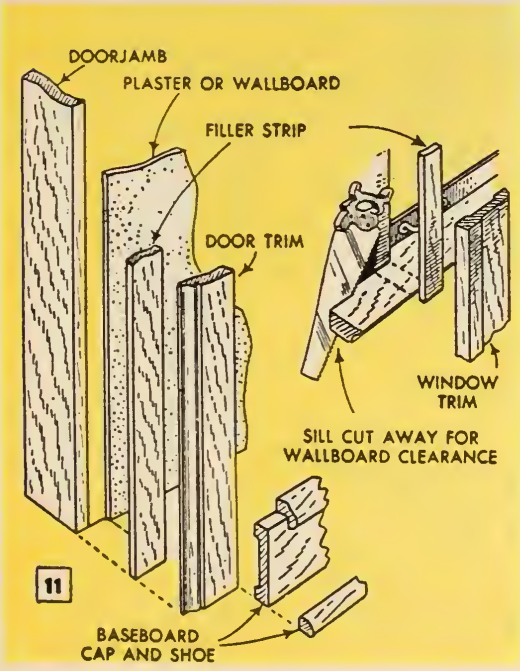

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should be about ¼ in. If desired, you can use a piece of metal lath instead of wood lath, cutting it with tin snips and attaching it with ¾-in. staples.

Before patching, brush away all loose particles from the edges of the old plaster. Then wet the lath and plaster edges thoroughly. A pointing trowel or regular plasterer's trowel is more convenient to use in filling intermediate-size patches than a putty knife. A single, thick layer of patching plaster over lath, particularly on ceilings, often tends to sag. Therefore, after wetting the plaster edges and lath thoroughly, start by applying a layer to just cover the lath, pressing it down firmly to key it properly as in Figs. 8 and 9. After this has set, add more to build up the thickness until it comes ⅛ in. below adjoining plaster. Allow the plaster to dry overnight, then wet the surface and fill flush with a vinegar-retarded mixture so that you will have time to finish the surface properly. To match a smooth adjoining surface, use a trowel. To match a sand-float finish, add an equal amount of sand to the last batch of plaster and use a wooden float, Fig. 22, to even the surface. To get a surface level, check with a straightedge placed across the patch. While the filling is still soft, surplus plaster can be scraped off with the straightedge or with a wide metal scraper, moving it back and forth with a sawing motion while pushing it ahead. If adjoining surface is textured, allow the patch to dry, then apply texture paint as described under heading, "Covering unsightly walls."

For patches larger than a foot or so square, it's easier and more economical to use regular prepared plaster, application of which is covered under the headings, "Base-coat plaster" and "Finish coat."

Using trowel or float: When using a trowel or float for smoothing plaster, move it sideways, lifting the forward edge a trifle so it rides over the surface to avoid cutting into it. Keep the working surface of a trowel or float clean and smooth. When the finish surface starts to set, it can be troweled smooth and glossy by wetting the trowel a little, or running a wet brush ahead of the trowel as in Fig. 24. The float also should be dipped in water as necessary so that it won't adhere to and drag out soft plaster.

Covering unsightly walls: Old walls and ceilings that show many scars of previous patching jobs improperly done, may be restored to excellent appearance by covering with texture paint, provided the old plaster is securely attached to the lath. Texture paints, available in many tints, are of heavy consistency to permit filling low spots to produce a uniform surface. This may be pleasingly textured with brush marks, swirls, mottling with sponge or crumpled

paper, or it can be stippled with a brush.

Replacing walls and ceilings: When loose plaster extends over large areas, it is probable that the entire wall or ceiling must be renewed for safety as well as for appearance. For a complete replastering job all old plaster must be removed; that between the laths is raked out or pushed back so spaces are open. If only a ceiling is replaced, a 2 or 3-in. strip of plaster is removed also from the top edge of walls as in Fig. 10. Strips of metal lath or ready-made corner strips are installed in corners to prevent cracks. The strips are fastened to studs and joists with large-head nails or long staples, spaced 6 in. where possible. You can do all this preparatory work and have a professional plasterer finish the job.

An unsightly ceiling, still tightly attached to the lath, can be covered with a new plastered ceiling if the supporting framework is strong enough to bear the added weight. Here, a plaster base of metal lath over furring strips, or self-furring metal lath, is installed, using washers and nails which are long enough to enter the joists about 1½ in. The nails should be spaced about 6 in. apart. Bend the lath to overlap walls where a narrow strip of plaster is removed, Fig. 10. Covering walls in this manner involves removing all trim and installing filler strips to bring door and window casings flush with the new plaster, Fig. 11. Considering this added work and expense, it may be better generally to remove the old plaster. In many cases, however, you can substitute ⅛-in. hardboard or ¼-in. wallboard for plaster, although this, too, requires the removal of trim and the addition of filler strips, Fig. 11.

Plaster bases: Either metal lath or gypsum lath is used for supporting plaster. Metal lath comes in sheets approximately 27 in. wide and 96 in. long. On large wall areas the sheets are run horizontally, the ends overlapped 1 in. and the edges about ½ in. Horizontal edges are held together with galvanized tie wire midway between studs. The sheets also are staggered so that the ends come on different studs or joists. Metal lath is nailed or stapled to these supports every 6 in., and is bent to fit inside and outside corners, running it past them to the next support to prevent corner cracks from developing.

Gypsum lath, Fig. 12, comes in 16 x 48-in. sheets, ⅜ and ½ in. thick. Some types are perforated to give a mechanical key besides the natural bond by suction. The sheets are nailed directly to studs and joists, or furring strips, with 1⅛-in. standard blued lath nails spaced 5 in. apart. For certain types of "floating" assembly, the lath is held by metal clips attached to studs and joists. Sheets are placed horizontally,

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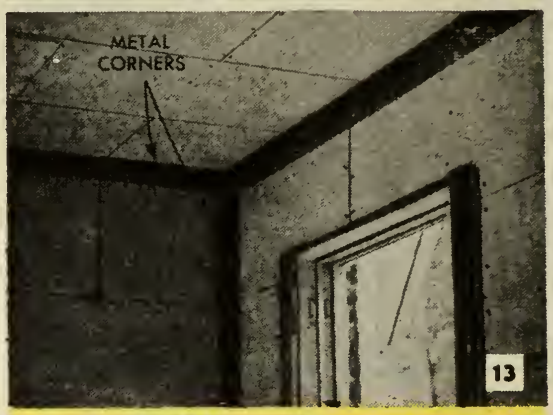

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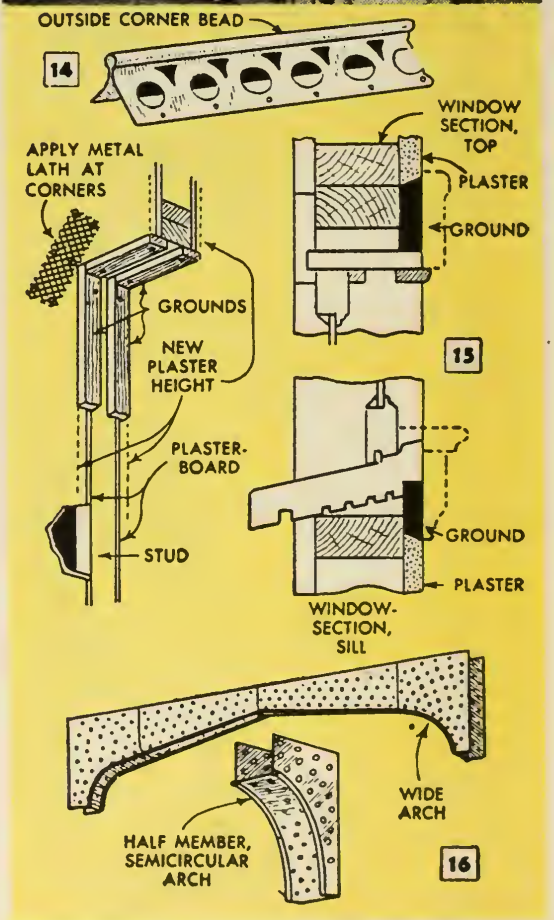


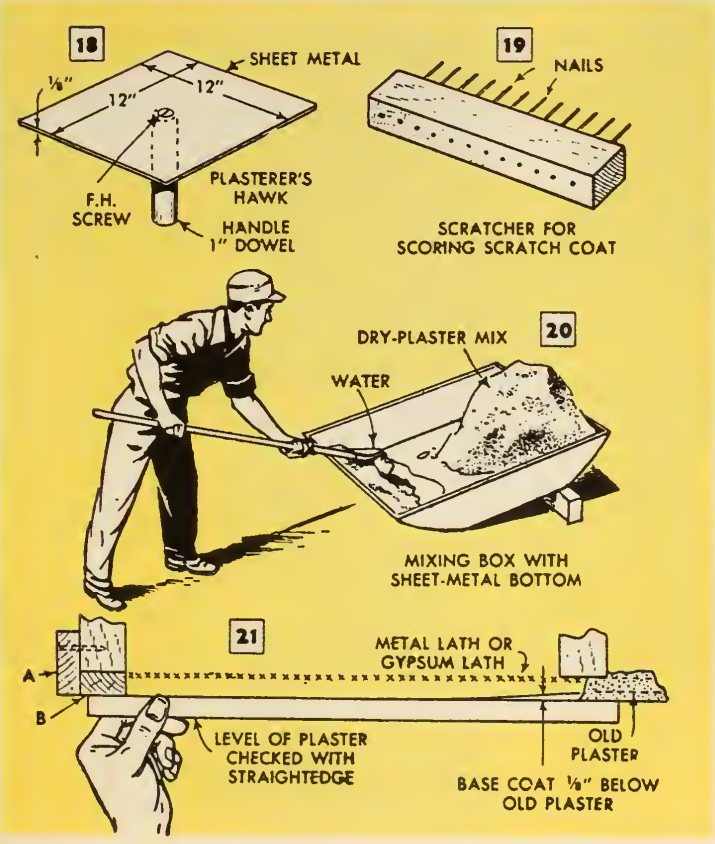
17

face side out, and are staggered so that the ends will come midway on different nailing supports. Use gypsum lath only as a base for gypsum plaster. Reinforce the corners where two walls meet, or those where walls and ceiling join, with special corner covering or prebent strips of metal lath, Fig. 13. Reinforcing strips are provided also over the upper corners of doors and windows (Fig. 15) to prevent cracks.

Corner bead, grounds, metal arches: For outside corners over any type of plaster base, you use corner bead, Fig. 14. This protects the plaster against blows and also provides a "ground" to which plaster comes flush. The corner should come exactly to plaster height of both adjoining walls.

Grounds at door openings which are cut through an existing wall or partition are installed as in Fig. 15 and later removed. Permanent grounds are placed along window casings or nailed across studs to come just below the top edge of baseboards. Sometimes an additional one is installed at floor level. In many remodeling jobs, the old wall to which plaster is joined serves as a ground, and the other grounds are adjusted to this height. The edges of old plaster should be cut off as smooth as possible to make the joint inconspicuous.

Ready-mixed plaster: Prepared plaster is available in which the right ingredients are exactly proportioned by manufacturers, requiring only the addition of water. Always follow carefully the manufacturer's directions. Gypsum plaster should not be used on outdoor walls, concrete or asphalt coatings, or on walls subjected to much moisture. But it can be applied to clean brick or building tile.

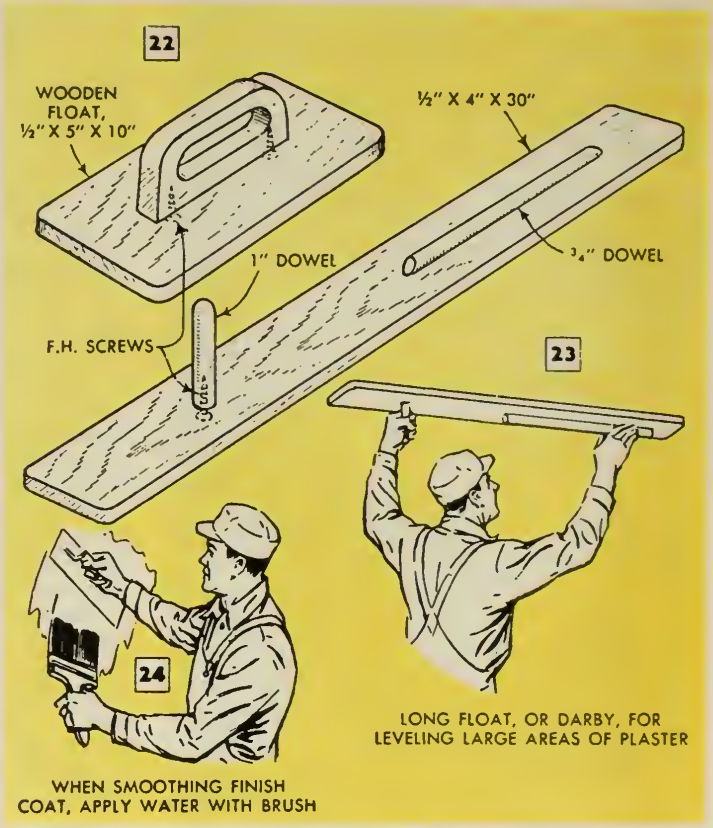


Base-coat plaster: The standard minimum thickness of plaster for new construction is ⅝ in. over metal lath and ½ in. over all other lath. In remodeling jobs, new plaster should come flush with the old plaster to which it is joined. Plaster is applied in separate coats—one coat of base plaster over gypsum lath, but two over metal lath, followed by a finish coat in each case. If the wall is to be painted or papered, the finish coat may be omitted.

Mix the plaster in a watertight box with sloping ends, Fig. 20. Mix only as much plaster as you can use in an

hour. Don't add water after the plaster has started to set, and don't mix plaster of a previous batch with a fresh batch. Put some on a hawk, Fig. 18, and apply it with a plasterer's trowel.

When applying plaster to lath, press the first coat down and work it through the spaces of the wood lath, or mesh of metal lath, to obtain good keying, or to form good bond to gypsum lath. Then, cover the lath about ¼ in. Score crisscross grooves about ⅛ in. deep while the plaster is soft, using an improvised scratcher, Fig. 19. After the first coat has set hard, apply a second coat as in Fig. 17, to come flush with the ground. Where the new plaster joins old plaster, soak edges with enough water to prevent rapid absorption of moisture from the new plaster. Soak the edges of the old plaster either with a sponge or a brush. The plaster and lath should be soaked just prior to patching.



It's best to keep the base coat ⅛ in. below the surface of old plaster, where it joints, Fig. 21. Run the corner of the trowel along the old plaster edge, and then "wipe" the plaster with a trowel back slightly, returning gradually to the plaster height of other grounds. To get plaster level, use a straightedge across the grounds as in Fig. 21. For good adherence of a finish coat, the surface of the base coat should be slightly roughened by using a float, Fig. 22. Use a long float, Fig. 23, for large areas.

Finish coat: You can also buy prepared finish plaster. There are two kinds: smooth, trowel finish and sand-float finish for use with steel trowel or float respectively. The base-coat plaster must be hard when the finish coat is applied. If dried out, moisten the surface but do not soak. "Skim" on finish plaster in two applications, Fig. 25, producing a coat from 1/16 to ⅛ in. thick. As soon as the first application has set enough to prevent its wrinkling, skim on the second. When the plaster starts to set, give it a final troweling for a smooth, glossy finish, using a clean wet brush ahead of the trowel, Fig. 24, but use water sparingly. For an extra-hard surface, use Keene's cement in the proportion of 25 lbs. of dry, hydrated lime to 100 lbs. of Keene's cement.

(Some photos courtesy United States Gypsum Co.)

COVER IT WITH

STICK-ON PLASTIC

By Theodosia Carpenter

Makes many common household items take on a brand-new look. Adhesive backing lets it stick securely yet permits it to be peeled off like masking tape. Wipes clean with cloth

YOU'VE PROBABLY used masking tape and know how easily it can be peeled off. That's the way a waterproof decorative stick-on plastic works, except that a paper backing must be peeled off to expose the adhesive coating. The peeling feature makes the material exceedingly easy to apply—if you make an error in positioning it the first time, simply peel it off and start over. Or, if you wish to change to a new color scheme, just pull it off and begin anew. It can be applied to any smooth surface, adds a durable skin-thin layer of plastic and comes in rolls 18 in. wide. It can be obtained in peppermint stripes, gay kitchen and nursery prints, solid colors, wood grains and marble patterns.

When applying the plastic to a kitchen work area or marred table top, first fill deep scratches and gouges with wood filler and sand smooth

A candy-striped "bib" of stick-on plastic waterproofs and decorates the splash area of this washbowl. Note matching mirror frame in plastic

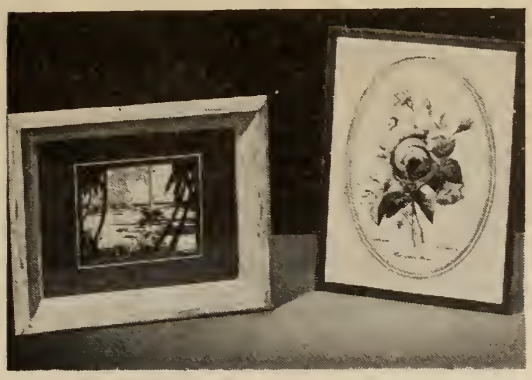
Plastic covering makes companion pieces of this wastebasket, talcum can and cleanser can. Below, no water, paste or tools are needed. Cut in the desired shape, remove backing and apply

Printed designs are easy to cut from stick-on plastic and used like decals. Cut out before removing backing

One of several brands on the market is Con-Tact which is shown being applied in the photos. In the craft field, stick-on plastic can be used to transform many common articles into attractive pieces. A plain potato-chip can, for example, can be converted to an elegant bathroom wastebasket by covering it in a spiral pattern. The top and bottom are wound with white plastic clothesline glued in place. Matching pieces are a talcum-powder can and a scouring-powder can holder.

Stick-on plastic is excellent for covering books and magazines. In the time normally required to make a paper jacket, a book can be given a sturdy, permanent binding. The spine is covered first with a piece that extends well over the book covers. Matching or harmonizing pieces are cut about

Weathered and damaged sills take on new beauty when covered with wood-grained waterproof plastic



The numerous colors and patterns offered in the material afford a good covering for picture frames

½ in. larger than the covers and stuck in place. Next the corners are mitered and the edges folded over. An appropriate pattern is used for end papers. If the book is coming apart, the end paper should extend both across the inside of the cover and the facing page.

Magazines are given a hard binding in much the same way. The front cover is cut off and a piece of cardboard of the same size substituted, while another is added on top of the back cover. After the binding has been attached, the magazine cover is pasted on the front.

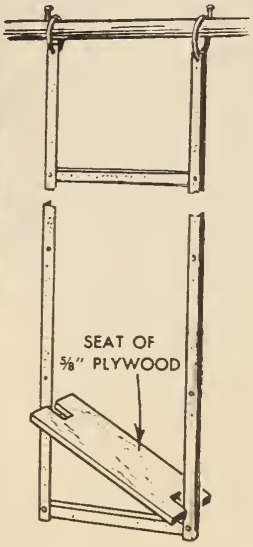
Plastic coverings for kitchen tables are inexpensive and good looking. Working surfaces in the kitchen may be restored to a new appearance with the durable material. Its adhesive characteristic makes it especially useful for covering shelves and window sills.

This marble pattern lends a distinctive note to the dressing table and gives it added serviceability

Because it is waterproof, the product offers a wide variety of uses in the bathroom, as a splash covering around the washbasin or as a colorful frame on the wall around the medicine cabinet. The imitation wood grains are excellent for "paneled" dens or playrooms, while the patterned pieces make lasting washable wall coverings for bathroom and kitchen. ★ ★ ★

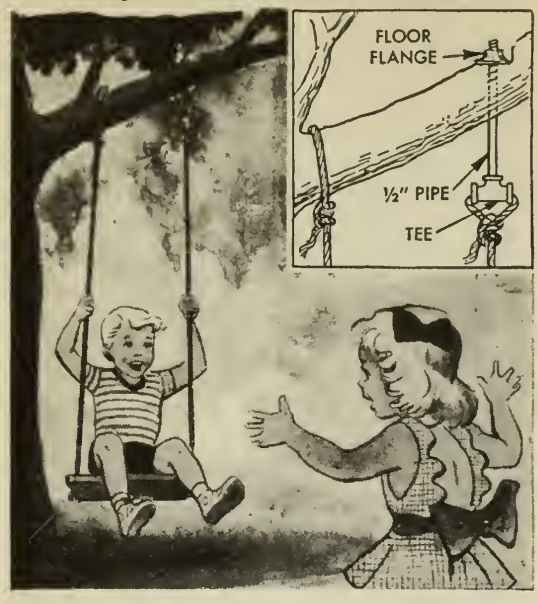
PLAYGROUND EQUIPMENT

Nontipping Swings for Gym Set



A ladder salvaged from a dismantled windmill will make several nontipping swings for a home-built gym set. Several rungs are removed from each ladder section and a notched board is added for a seat. The swings are hung to the cross-pipe framework with rings formed of ¼-in. steel rod and later welded. Bolts in the pipe next to each ring provide stops to keep the swings from wandering sideways on the pipe. A dab of grease applied to the rings will make the swings noiseless, and a coat of paint will keep the swings from rusting.

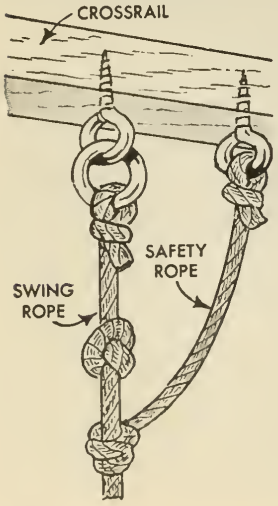
Pipe Extension Lowers Swing Rope To Compensate for Slant of Limb



To make the ropes pivot at the same level when hanging a child's swing from the slanted limb of a tree, tie the outer rope to a pipe extension. Hung in this way, the swing will move in a straight arc. Cut a flat on the upper portion of the limb at the point where the outer rope is to be hung and drill down through the flat to permit inserting a length of ½-in. threaded pipe. Pass the pipe through the hole and fasten it with a floor flange as shown in the detail. Then turn a tee on the lower end of the pipe and tie the swing rope through the hole in the tee. The extension should lower the outer rope so that it pivots at exactly the same level as the inner rope.

Dr. Bernard Matzen, Napa, Calif.

Safety Ropes on Swing Prevent Sudden Falls

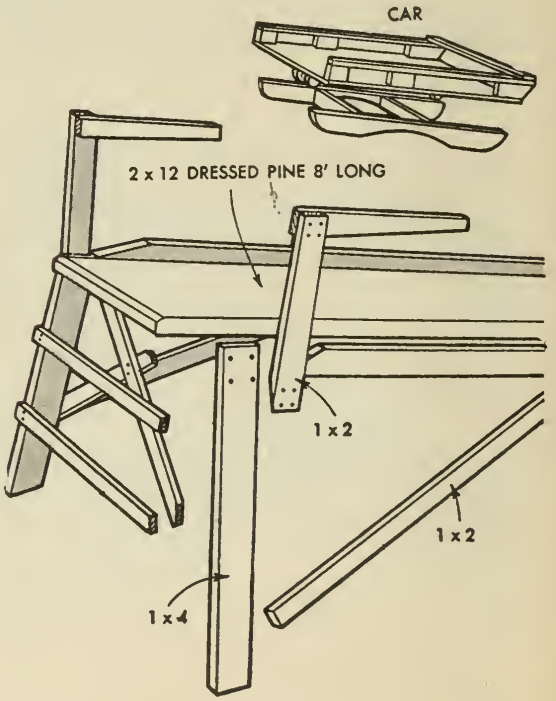


Sudden falls from swings caused by breakage of the rope or a hanger can be avoided by installing auxiliary safety ropes as illustrated. Be sure to tie a knot in each swing rope immediately above the point where the safety rope is attached. Leave a little slack in the safety ropes to permit movement of the swing ropes.

THRILLS GALORE ON

HERE IS a miniature version of one of the most popular of amusement-park rides, the roller coaster. You can set it up in the back yard or basement in less than an hour, once the members for the track and supporting structure are cut and assembled into one straight and one contoured section as shown in the drawing and details. Slight slopes and a relatively short over-all length permit rides on the one-passenger car that are exciting for small children, yet completely safe. There are no curves or high track, and guide rails on both sections prevent the car from jumping the track. If a longer track is desired, a second contoured section may be added.

The car is of wooden construction with the front half of a roller skate screwed to the underside just forward of the front crossbar as shown in the detail. The other half of the skate is attached similarly at the rear of the car. Except for the ½-in.-plywood bottom, the car is made of 1-in. lumber as shown in the details. Exactly 5/16 in. clearance should be allowed between the track and the members nailed to the ends of the crossbars on the underside of the car as shown in the end view. These members, which serve as stabilizers, enable the car to glide over the track without tip-



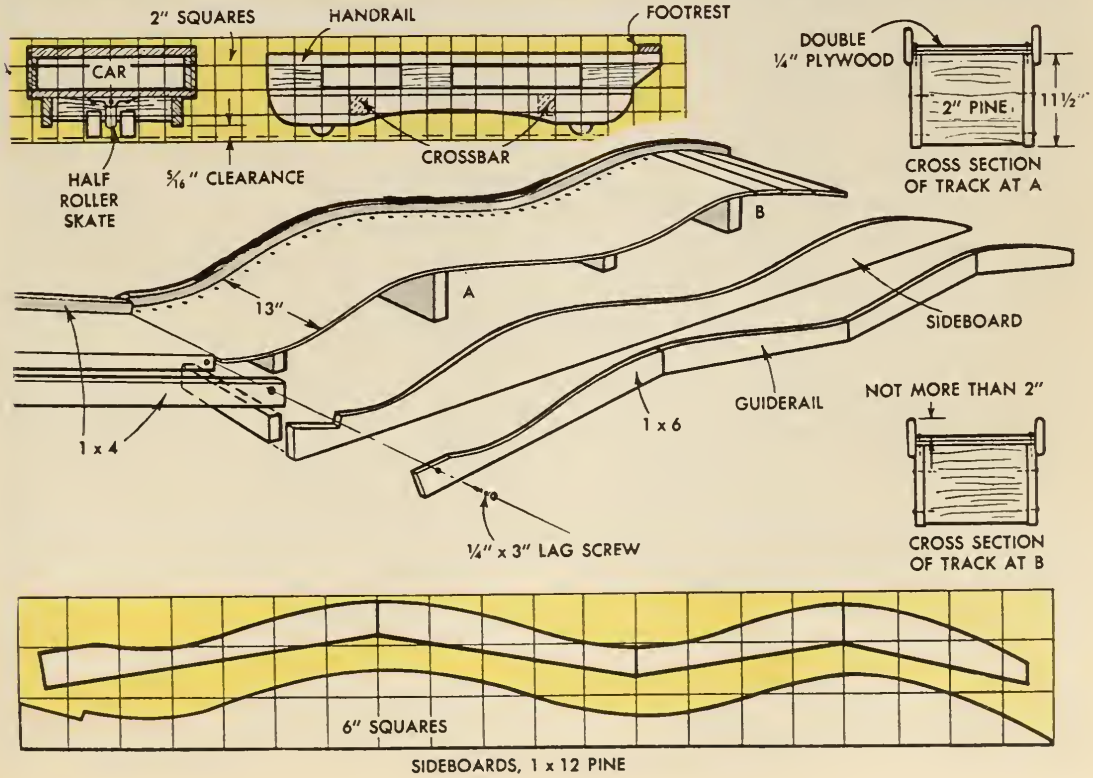
THIS ROLLER COASTER

ping and prevent it from climbing over the guide rails. A footrest at the front of the car provides added safety.

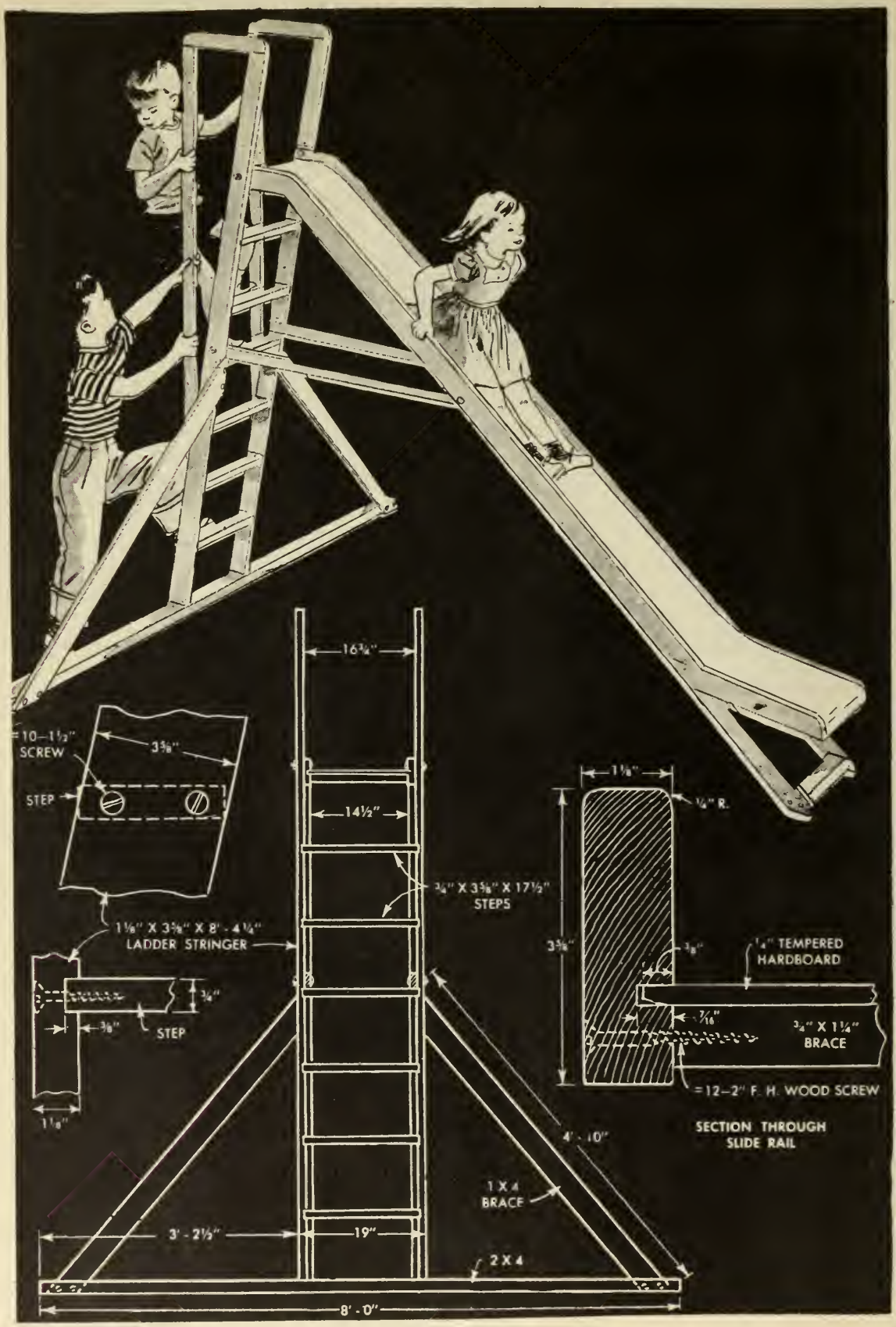
For the straight section of the track, an 8-ft. length of 2 x 12-in. pine is elevated 2 ft. at one end by two 1 x 4-in. supports braced by four 1 x 2s. A bevel cut on the upper end of the track prevents the car from rolling forward when boarding it. The lower end of the track rests on a crossbar and the ends of the sideboards of the contoured section and is joined to the latter section by two lag screws turned through the guide rails and into the 2 x 12.

After cutting the ¼-in.-plywood track for the contoured section, the pieces should be primed with linseed oil on both sides, then nailed to the sideboards and crossbars as shown in the details. Plywood or ½-in. lumber can be used for completing the contoured track. The guide rails should be well sanded and the car and track structure painted as desired to avoid injury from splinters and protect the wood. ★★★

Over-all length of track can easily be increased by adding one or more contoured sections for longer ride



SIDEBOARDS, 1 x 12 PINE


10—1½" SCREW
3⅜"
STEP
16¾"
14½"
¾" X 3⅜" X 17½" STEPS
1⅛" X 3⅜" X 8' - 4¼" LADDER STRINGER
¾"
⅜"
STEP
1⅛"
1⅛"
¼" R.
3⅜"
¼" TEMPERED HARDBOARD
1/16"
¾" X 1¼" BRACE
12—2" F. H. WOOD SCREW
SECTION THROUGH SLIDE RAIL
4' - 10"
1 X 4 BRACE
3' - 2½"
19"
2 X 4
8' - 0"

Children's Slide

MATERIAL LIST

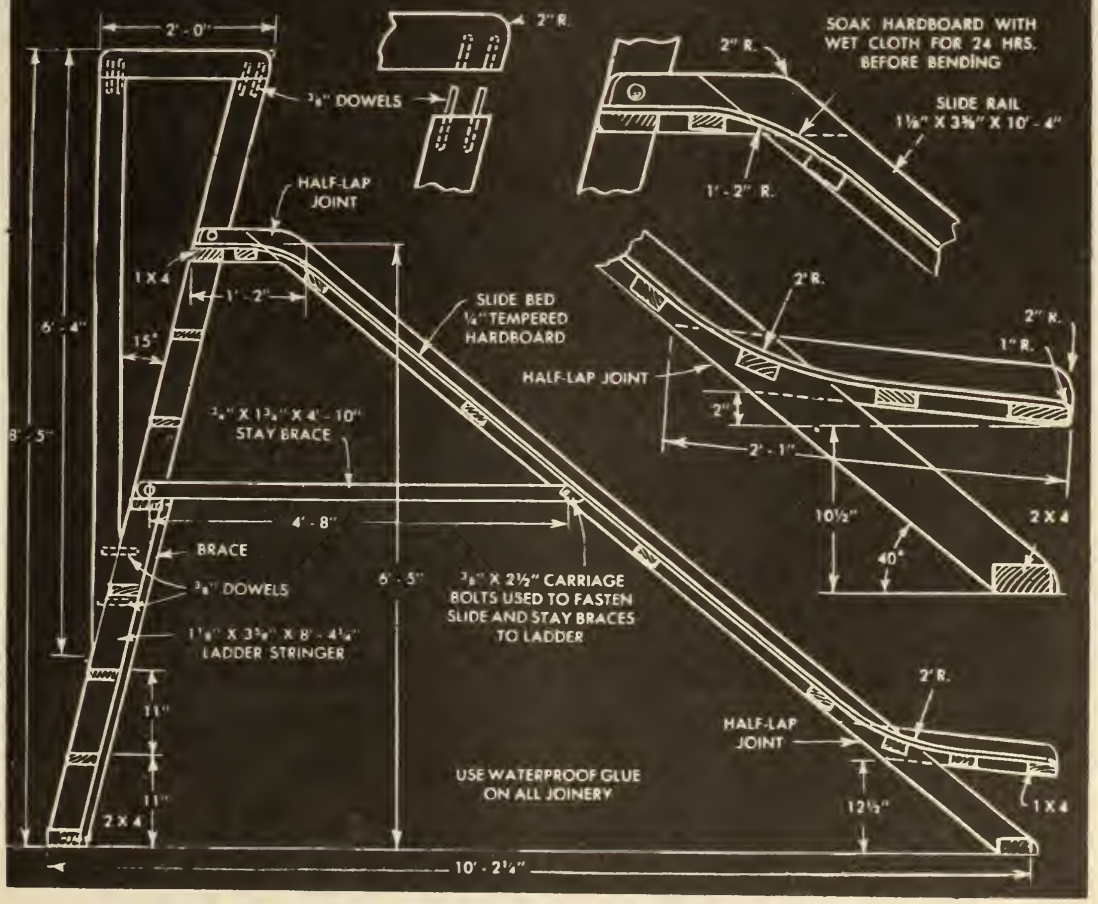
Tempered hardboard

1 pc. ¼" x 15¼" x 12' — Slide bed

Clear pine, redwood or cedar

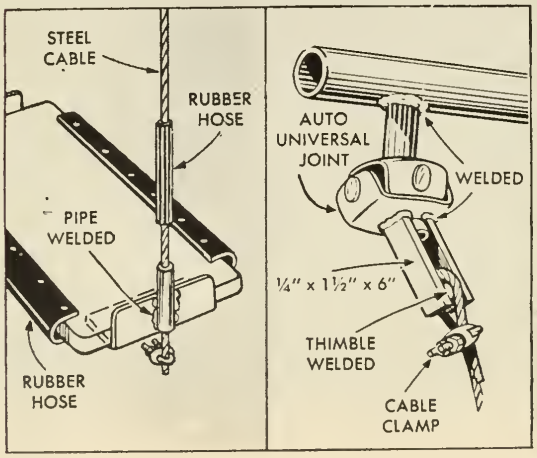
2 pcs. — 1⅛" x 3⅝" x 14" — Top slide rails
2 pcs. — 1⅛" x 3⅝" x 10' - 4" — Side slide rails
2 pcs. — 1⅛" x 3⅝" x 25" — Bottom slide rails
2 pcs.—1⅛" x 3⅝" x 8' - 4¼"—Ladder stringers
2 pcs.—1⅛" x 3⅝" x 6 - ⅜"—Ladder handrails
2 pcs.—1⅛" x 3⅝" x 24"—Ladder handrails
2 pcs.—¾" x 3⅝" x 4' - 10'—Braces
2 pcs.—¾" x 1⅝" x 4' - 10"—Stay braces
1 pc.—1⅝" x 3⅝" x 14½"—Slide base
1 pc.—1⅝" x 3⅝" x 8'—Ladder base
2 pcs.—¾" x 3⅝" x 14½"—Slide cleats
7 pcs.—¾" x 1¼" x 14½"—Slide cleats
6—⅜" x 2½" carriage bolts
36—#10-1½" flat-head wood screws
30—#12-2" flat-head wood screws

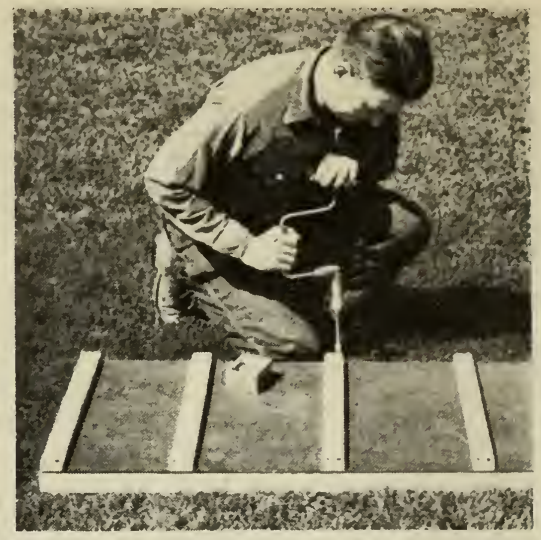
Shrieks of delight from your youngsters will well repay you for the few hours it takes to build this junior-size back-yard slide. It is designed to be made from stock lumberyard material to eliminate unnecessary cutting, and ¼-in. tempered hardboard is used for the bed of the slide. The sectional detail through the rail of the slide shows how the hardboard is held in grooves and supported at intervals by 1 x 2 cross members. Where it is necessary to curve the hardboard at the top and bottom of the slide, the material must first be dampened for about 24 hr. to make the hardboard somewhat pliable. This is accomplished by placing wet cloths over the points of bend and keeping them wet for the required period. An application of varnish followed by wax will protect the bed of the slide and make it as slick as ice. Note that ladder assembly and braces are attached to the slide with bolts for dismantling when storing the slide during the winter



Swing Strength and Safety

Both strength and safety are designed into this swing that uses steel cable instead of rope. The upper ends of the cables are looped over thimbles welded between steel flats that are part of a welded assembly made from auto universal joints as shown in the right-hand detail. Cable clamps are used to secure the loops, and to provide stops on the lower ends of the cables. The stops bear against short lengths of pipe welded to steel angles. The angles are bolted to the seats, which are cut from 2-in. straight-grained stock. Lengths of rubber hose, slit lengthwise, are tacked to the front and back edges of the swing seats as another precaution against injury. To protect hands, lengths of rubber hose are slipped over the cables, to form grips, as in the left-hand detail. Brightly colored paints are used to make a "barber-pole" effect on the swing frame to make it more visible.—John O. Bock, Yakima, Wash.



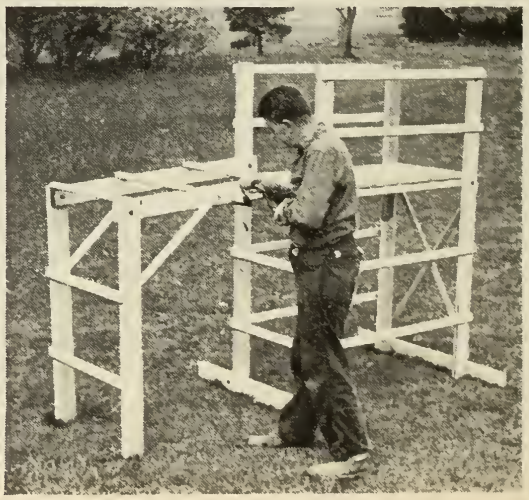


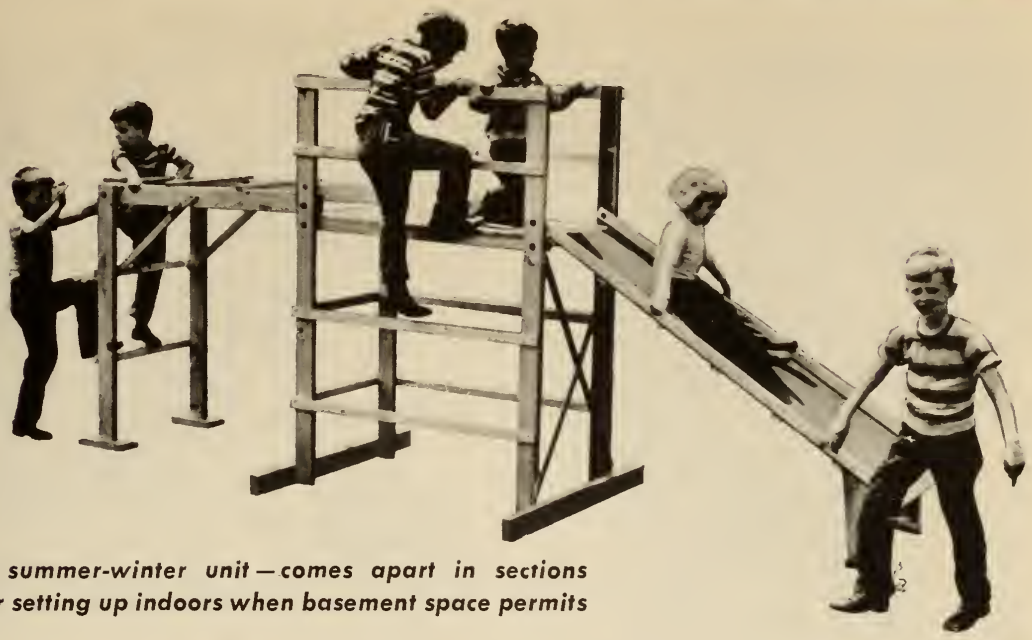
The tempered-hardboard slide surface is reinforced with 1 x 2-in. crosspieces spaced one foot apart

COMBINATION

IF YOU HAVE youngsters between two and eight years of age, here is a combination slide and exerciser which will bring them hours of healthful fun. It dismantles into three easily handled sections so it can be moved indoors and set up in the basement playroom during the winter months. The whole unit is made of standard lumberyard material, consisting mainly of 1 x 2s and 2 x 4s, with hardboard being used for the bottom of the slide. All wooden parts should be protected with a coat of paint followed with two coats of spar varnish. Varnishing and waxing the hardboard will give a slick surface. ★ ★ ★

To provide maximum strength and avoid splitting of the members, pilot holes should be made for screws

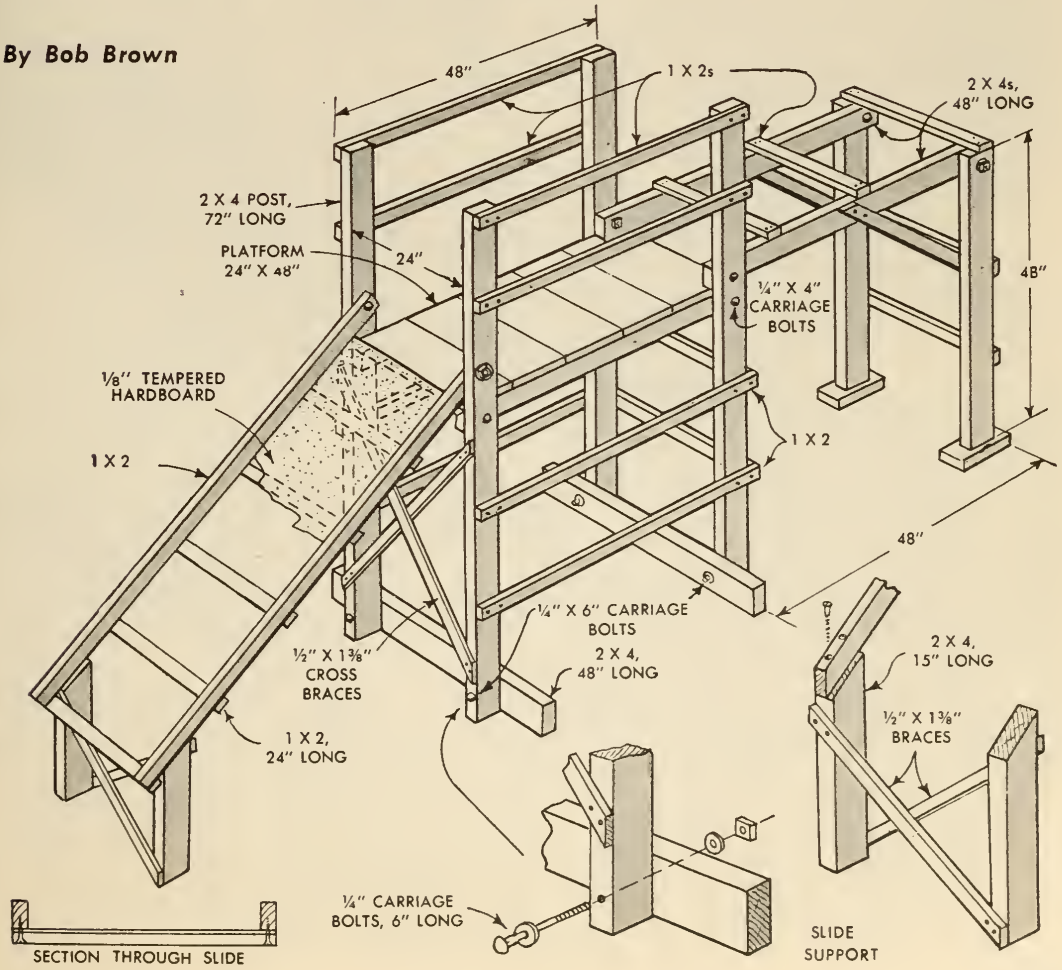


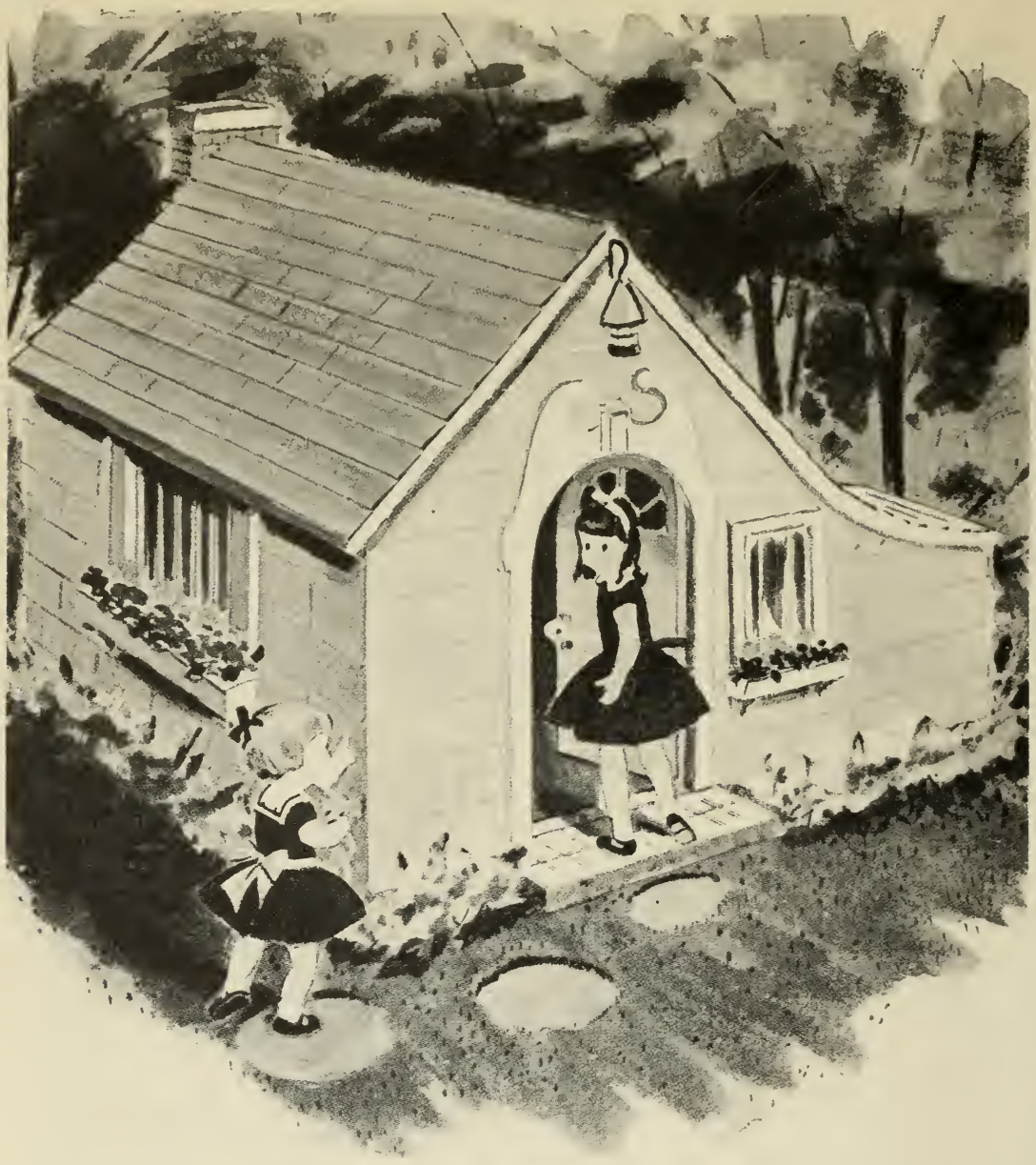


A summer-winter unit—comes apart in sections for setting up indoors when basement space permits

SLIDE AND EXERCISER

By Bob Brown





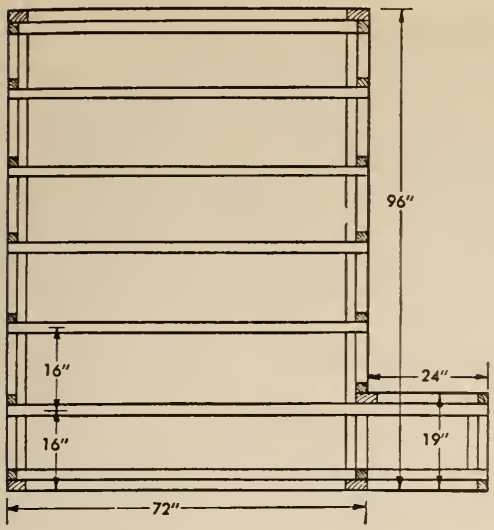
Deluxe Playhouse

has water and lights

By C. W. Woodson

ANY YOUNG LADY will feel like a fairy-tale princess when she is the proud owner of this enchanting playhouse that includes the modern magic of electric lights, running water and a heating plant. With the little house located in a corner of the back yard, Mother knows her daughter and friends are safely off the street, and she can check on the children's well-being in a moment.

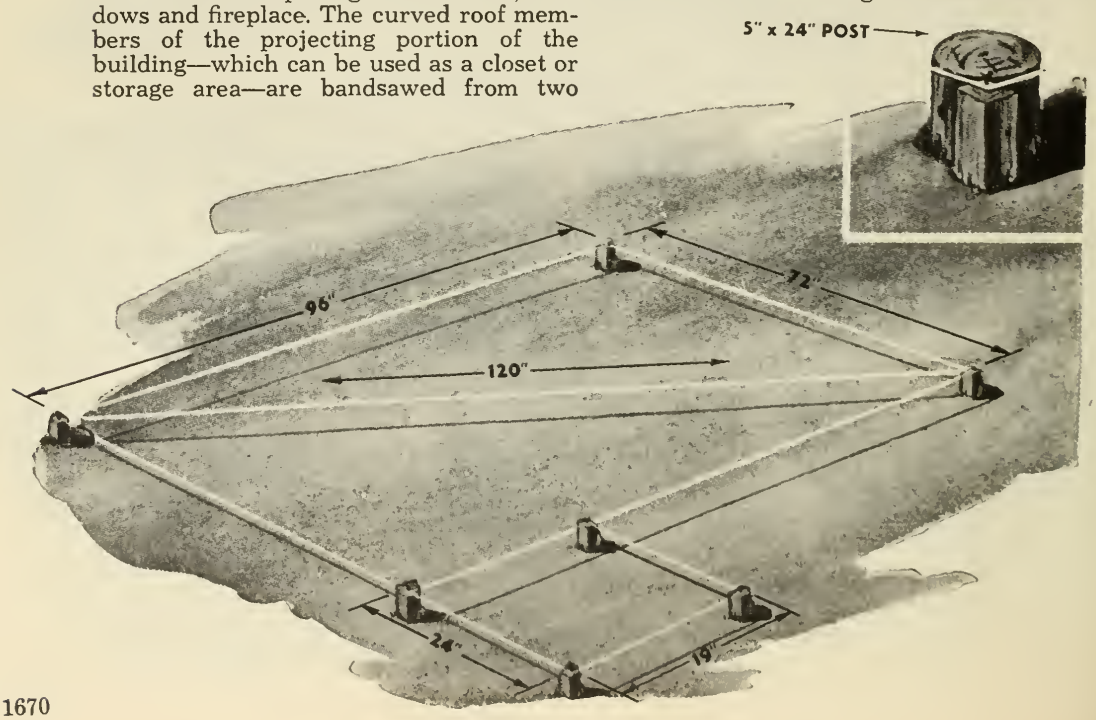
Construction of the playhouse starts with staking-out the foundation, as shown in the detail at the bottom of page 1670. Assure that the main 6 x 8-ft. foundation is square by measuring the diagonals, both of which should be exactly 10 ft. Cedar posts 5 in. in diameter are cut in 2-ft. lengths (longer in areas of severe frost) and sunk in holes dug just inside the stakes as indicated in the upper detail on page 1670. Use a long

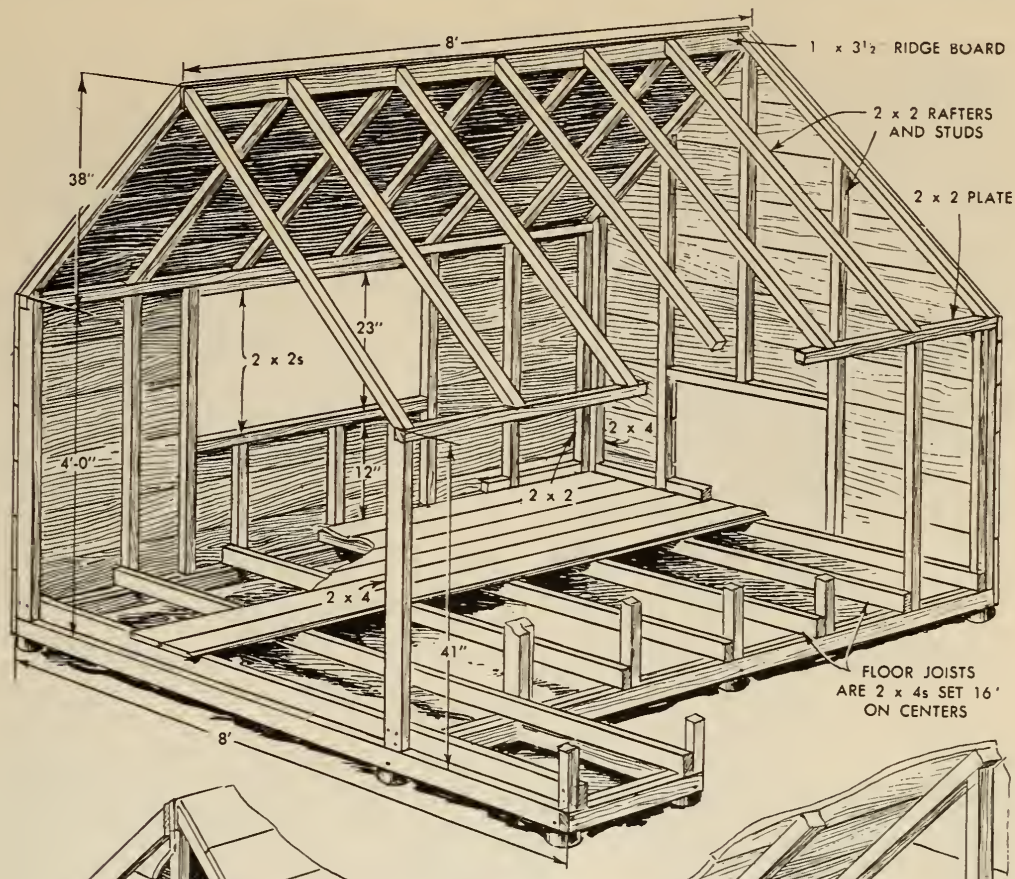


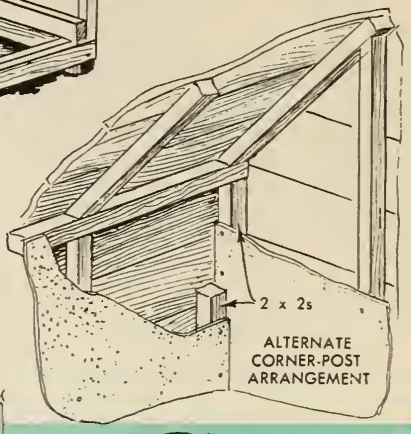
straightedge and level all the posts. A handful of gravel under a low post will bring it up to the right height. The foundation posts should project about 4 in. above the ground, which is high enough to permit ample air circulation under the building to prevent rot, while still being low enough for pleasing appearance. Sills, which can be either 4 x 4s or two 2 x 4s on edge, now are spiked to the foundation posts. Recheck the level of the foundation and shim up the sill where necessary. The floor joists next are toenailed to the sills. The joists are 2 x 4s on edge, and are spaced 16 in. on centers. After the first joist is nailed in place, a spacer block, lower right-hand detail, page 1671, can be used to speed work and assure accurate spacing. The joist plan at the left shows the joists in place and the location of wall studs that are spiked directly to the sills alongside the floor joists. Wall studs and roof beams are 2 x 2s, with the exception of the corner-post studs, which may be 2 x 4s, lower right-hand detail, page 1671, to provide a nailing surface for the interior wall covering. An alternate corner-post arrangement,

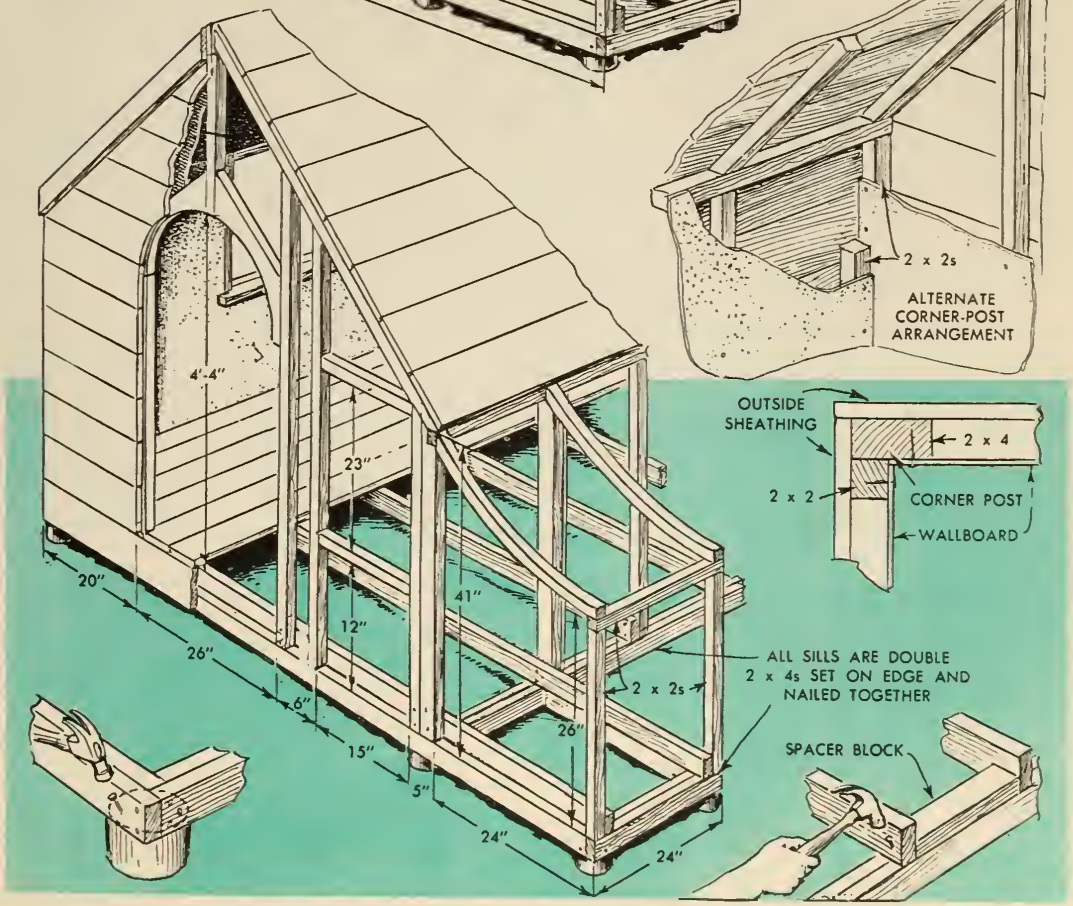
in which 2 x 2s are used, is shown in the right-hand center detail on page 1671.

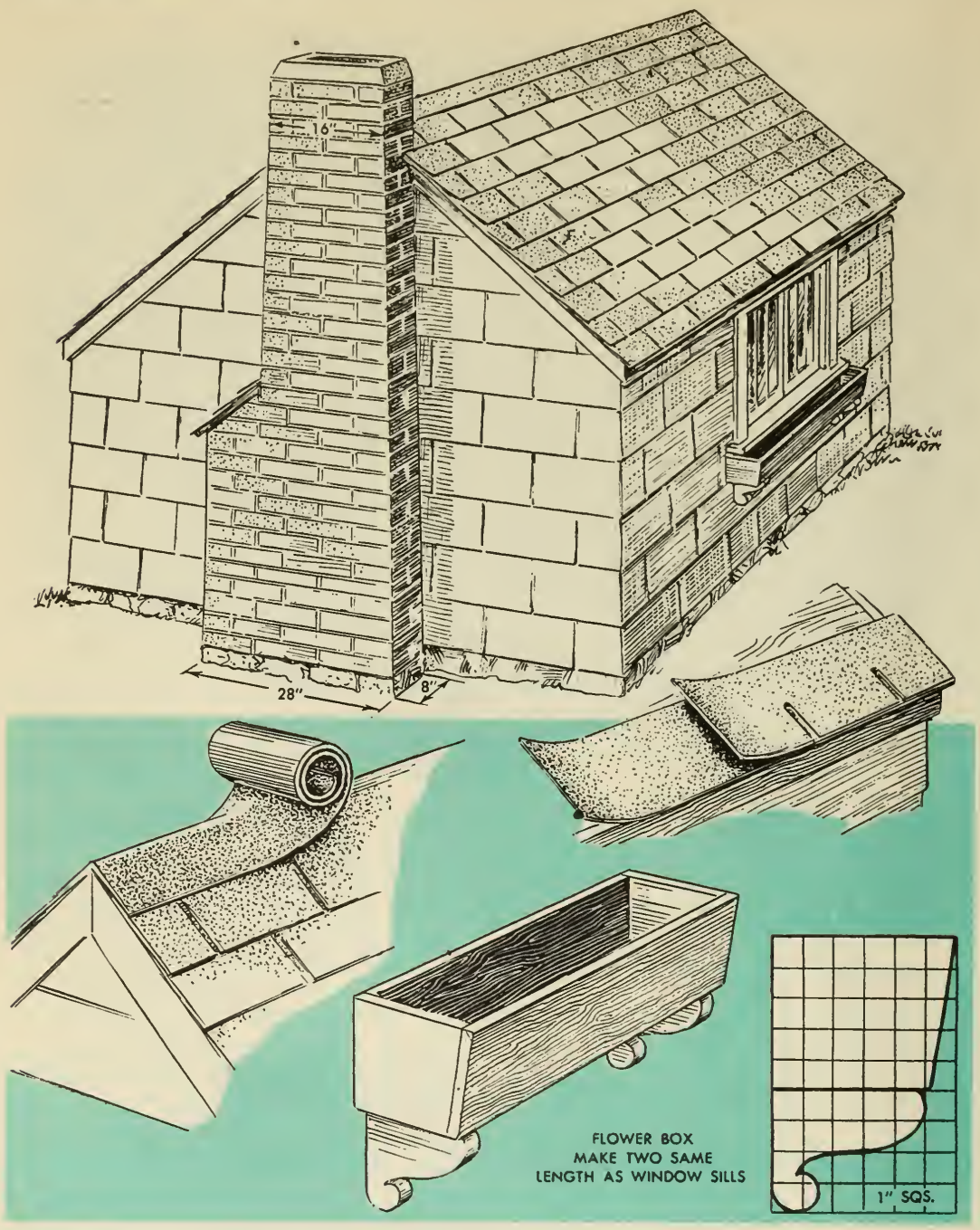
Carefully check all details on page 1671 to familiarize yourself with the methods of framing the building, as well as noting the locations of openings for the door, windows and fireplace. The curved roof members of the projecting portion of the building—which can be used as a closet or storage area—are bandsawed from two pieces of solid stock. The fireplace opening in the back wall is as wide as the space between two wall studs and should be high enough to provide ample space for the electric heater that is to be installed in this area. The framing members over the




8'
1 x 3½ RIDGE BOARD
2 x 2 RAFTERS AND STUDS
2 x 2 PLATE
38"
23"
2 x 2s
2 x 4
4'-0"
12"
2 x 2
2 x 4
41"
FLOOR JOISTS ARE 2 x 4s SET 16" ON CENTERS
8'

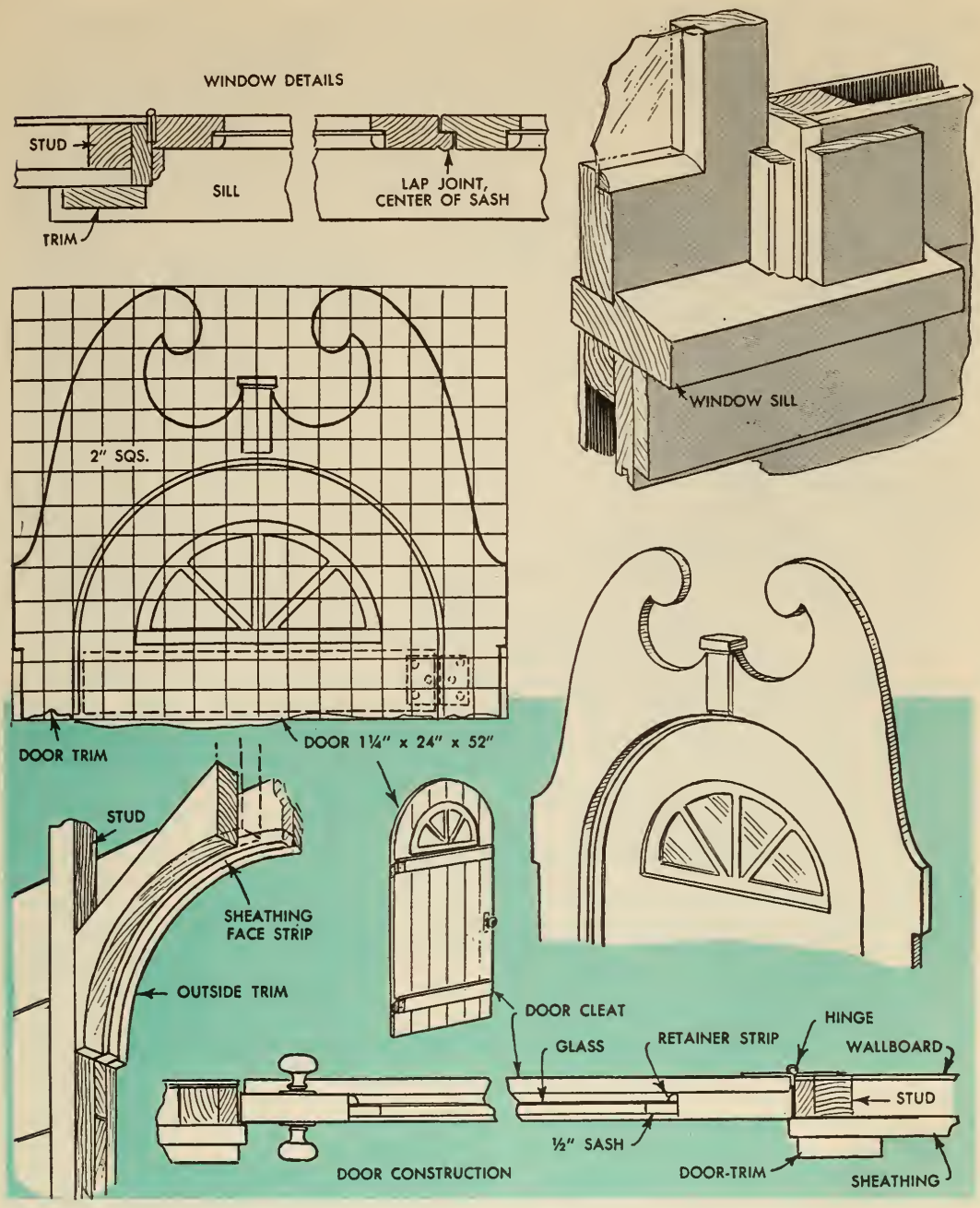

2 x 2s
ALTERNATE CORNER-POST ARRANGEMENT


4'-4"
23"
20"
41"
12"
26"
6"
15"
5"
24"
26"
24"
2 x 2s
ALL SILLS ARE DOUBLE 2 x 4s SET ON EDGE AND NAILED TOGETHER
SPACER BLOCK
OUTSIDE SHEATHING
2 x 4
2 x 2
CORNER POST
WALLBOARD



door opening are bandsawed from solid stock, using a 13-in. rad., or the pattern for outside door trim on page 1673 may be used to determine the curve of the inner edges of the framing members. Note that the lower ends of these members are the width of a 2 x 2 on which each will rest. This provides a double 2 x 2 member on each side of the door opening for additional strength.

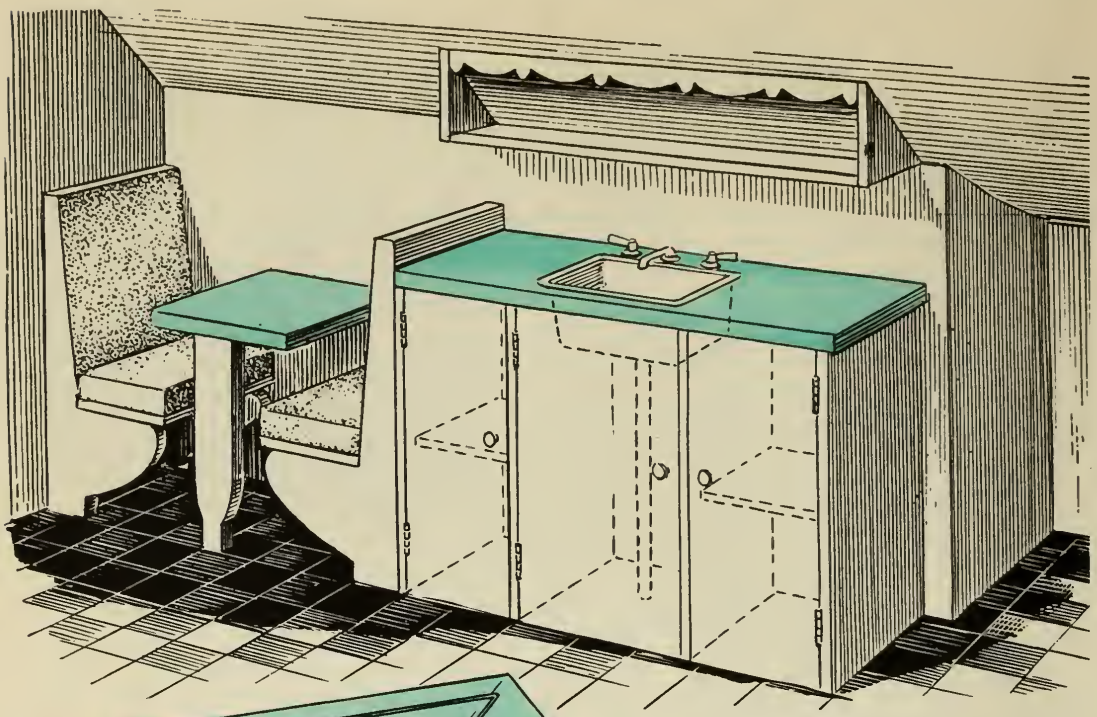
Tongue-and-groove sheathing is used for the floor of the playhouse, for roof planking and for wall sheathing. The sheathing goes on quickly and will assure a rigid structure. Around door, window and fireplace openings, the sheathing is applied so it is flush with the inside edges, as per details on page 1671. After the sheathing is applied, the chimney can be constructed. It consists of 1 x 8s fastened to cleats that are nailed to the sheathing. The rear face of the chimney then is nailed to the side pieces. The rear elevation of the playhouse detailed above shows the shape of the chimney, and indicates how the top of the offset in the chimney is shingled with the same material used on the roof. Imitation brick siding is used to cover the chim-

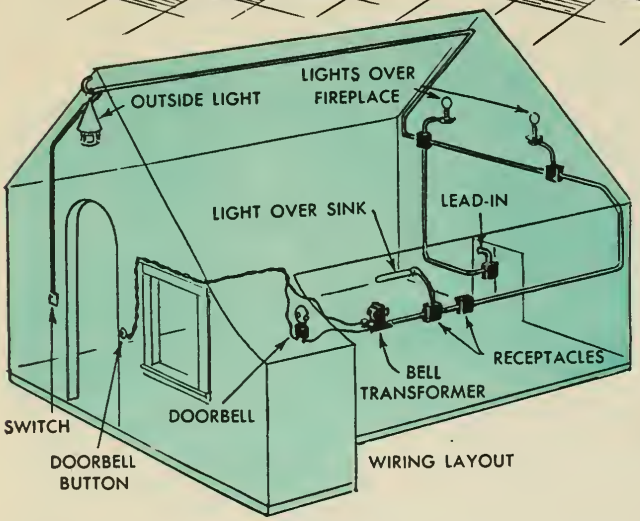


ney, and the top of the chimney is sealed against the weather by a sheet-metal or plywood cap. The latter is painted white to contrast with the red of the brick siding. Metal flashing is installed between the chimney and the roof, and also between the chimney offset and the sheathing.

Inside the chimney a horizontal plywood panel is installed just above the fireplace opening. It should be covered with metal so that it reflects the heat of an electric heater into the playhouse. The heater located in the fireplace is used to warm the little house on chilly days in early spring and late fall, permitting the house to be used a couple of months longer each year. To protect the lower edges of the chimney from ground moisture, it should rest on a stone or brick foundation.

Window-frame construction for the playhouse is detailed at the top of this page. If your workshop does not have facilities for building the window sash, it may be possible to use a stock window by altering the opening to suit, or a window can be ordered custom-built through most lumber yards. The double window on the side of the playhouse should be hinged to swing in,





while the single window beside the door is fixed permanently in its frame, the door providing necessary ventilation.

The arched front door, lower details, p. 1673, is built up from 1¼-in. clear pine strips glued edge-to-edge. Two cleats are glued and screwed to the inside surface of the door. The top of the door is rounded on a bandsaw and the fan-shaped window opening is cut out with a keyhole saw. A single piece of glass is fitted into this opening, divider strips and edge molding being cemented to the face of the glass and to the inside edge of the opening.

The scroll over the door is part of the outside trim and is cut from a single piece of plywood, using the squared pattern on page 1673. Straight trim is run from the lower edge of the arch to the door sill.

After the house trim is in place it should be primed, and all joints calked, since these cannot be done after the shingles are attached. The roof now is shingled, using fire-resistant, slate-surfaced shingles of the square-end type, laid 4½ in. to the weather. The side walls of the house are covered with 24-in. prestained shingles with 9-in. exposure to the weather. Flower boxes can be attached beneath the windows.

If local codes require it, wiring in the playhouse should be done by a licensed electrician, according to the diagram on this page. Running water and a drain for the playhouse sink are plastic garden hose. The sink set in the counter top is a plastic or metal basin such as used in house trailers and boats. Other built-in furniture can consist of a breakfast nook as shown in the illustrations, or toy furniture can be used. For ease of cleaning, the playhouse floor is covered with linoleum. Either hardboard or insulating wallboard can be used for interior covering of the walls. Both can be painted to provide a cheerful appearance and ease of cleaning.

Added luxuries, such as a radio, record player or television set can be added to the furnishings of the playhouse, depending on the age and interests of the residing princess. But no matter what the furnishings, childhood magic will be there. ★ ★ ★

Photos by Don Honick

This little 6 x 8-ft. prefab, designed by The Masonite Corp., makes an exciting dream home for tiny tenants

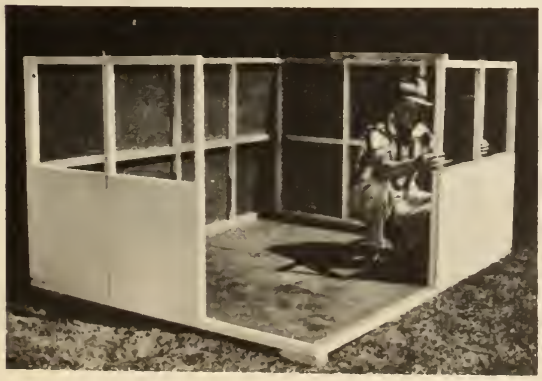
TAKE-APART PLAYHOUSE

Comes apart in easy-to-handle sections so it can be set up indoors during winter for year-round play. Made of durable hardboard, it takes paint beautifully

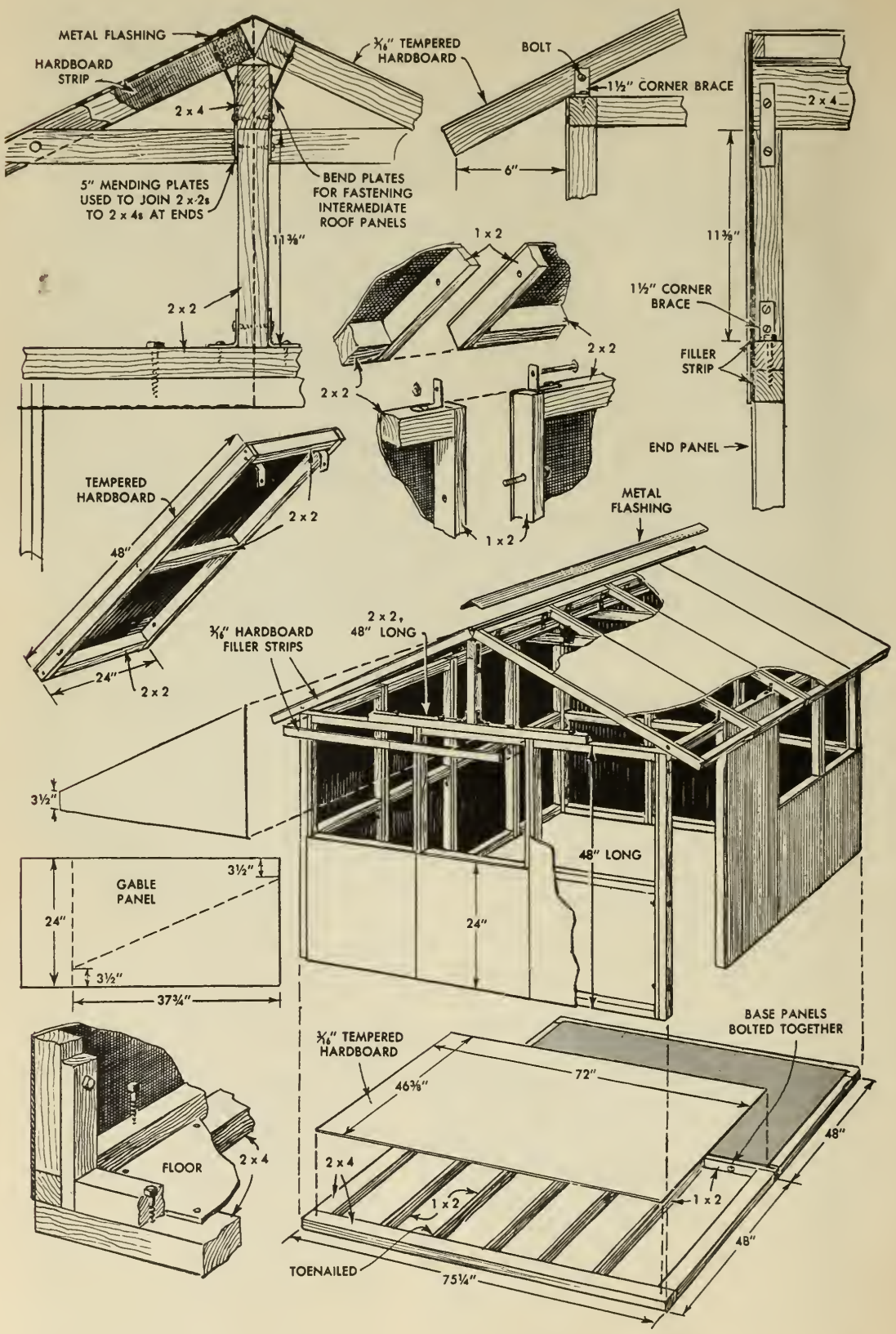
A PLAYHOUSE is far from an inexpensive toy, but when it is designed for year-round play, it becomes less of a luxury when you consider the additional hours of fun it will afford your youngsters compared to other seasonal toys.

While it is true that a lot of basements will not permit setting up the house in its entirety, its take-apart feature makes it possible to erect a smaller version of the house where space is limited. The walls and roof panels are interchangeable like the parts of a construction toy so that just half the house can be set up for indoor play. Basement headroom will be of no concern in most cases as the total height

Modular panels make erection simple. Intermediate panels are interchangeable to vary windaw location



One lag screw anchars each panel to floor; two ¼ x 2½-in. carriage bolts fasten panel to panel


METAL FLASHING
HARDBOARD STRIP
2 x 4
5" MENDING PLATES USED TO JOIN 2 x 2s TO 2 x 4s AT ENDS
BEND PLATES FOR FASTENING INTERMEDIATE ROOF PANELS
11⅜"
2 x 2
⅛" TEMPERED HARDBOARD
BOLT
1½" CORNER BRACE
6"
2 x 4
11⅜"
1 x 2
2 x 2
2 x 2
1½" CORNER BRACE
FILLER STRIP
END PANEL
1 x 2
TEMPERED HARDBOARD
2 x 2
48"
24"
2 x 2
METAL FLASHING
⅛" HARDBOARD FILLER STRIPS
2 x 2, 48" LONG
3½"
GABLE PANEL
24"
3½"
3½"
37¾"
48" LONG
24"
FLOOR
2 x 4
¼" TEMPERED HARDBOARD
46⅜"
72"
BASE PANELS BOLTED TOGETHER
48"
2 x 4
1 x 2
1 x 2
48"
TOENAILED
75¼"

of the house is a little more than 6 ft. Window and door openings can be rearranged, and screens and movable sash, as well as a door, may be added.

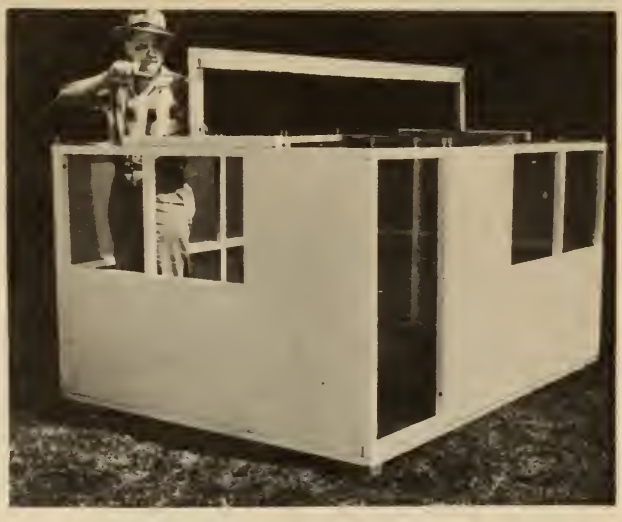
Framework of Stock Lumber

Except for the two floor panels which measure 4 x 6 ft., all others are made 2 x 4 ft. Counting the door panel, which really isn't a panel but rather a three-sided frame, you'll need 14 wall panels, including 4 corner panels, and 8 roof panels. The corner panels differ from the others in that a 2 x 2 is used along one side instead of a 1 x 2. Other than this, all panels are assembled exactly alike, using 2 x 2s for the cross members and 1 x 2s for the side members. These are nailed together to form simple frames which are covered on the outside with $\frac{3}{16}$-in. tempered hardboard. Four of the panels are made half panels to provide window openings.

The two frames for the floor panels are assembled from 2 x 4s and 1 x 2s, the latter being set on edge and the 2 x 4s placed flatwise. The top sides are floored with hardboard. By ripping $1\frac{5}{8}$ in. from the long side of two 4 x 6-ft. sheets, the hardboard will be just the right size to leave a $1\frac{5}{8}$-in. border around the four sides.

Panels Bolted Together

Pick a level spot of ground to place the floor after bolting the panels together from the underside. Start erecting the walls by fitting a corner panel first. As with all panels, a single lag screw in the center of the bottom rail is used to fasten the corner panel in place. Two bolts are used, one at top and bottom, to join each panel to the succeeding one. After the walls are erected, a 2 x 2 stiffening member, 48 in. long, is lag-screwed to the top of the end walls, bridging the center panels. This member supports the 2 x 2 posts that in turn support the 2 x 4 ridge board to which the roof panels are fastened with mending plates. Angle brackets anchor the roof panels to the walls. Each gable end of the house is faced with two hardboard panels cut from a 2 x 4-ft. sheet. To make these overhang the covering on the wall panels and provide a drip edge, narrow filler strips of the material are first nailed to the outside edges of the end roof panels, the posts and the stiffening members. The gable panels are fastened with roundheaded screws. Finally, the ridge is covered with a sheet-metal flashing, and 1 x 2 braces are installed on the inside of the house to join both halves of the roof. ★ ★ ★



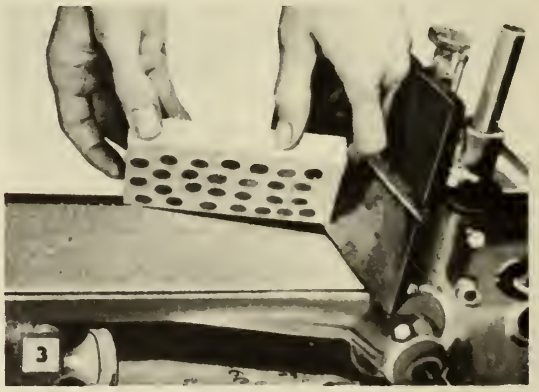
Ridge board is supported at each end by 2 x 2 posts which are fastened to walls with metal angle brackets

Above, two 1 x 2 members are used to tie each side of the roof together after the panels are all in place. Below, individual roof panels are attached to the ridge board with screws and mending plates, the plates being bent

SCREW-HOLE PLUGS MADE FROM DOWELS

HERE'S A METHOD of making screw-hole plugs fast and in quantity. First, you drill blind holes to a uniform depth in a piece of waste stock. As will be seen, the depth of the holes determines the length of the plugs. Of course, the holes must be the same diameter as the dowel. Cut the latter into short lengths, each length slightly greater than the depth of the holes in the waste piece. Press the rough plugs thus made into the holes in the waste piece as in Fig. 2 and sand flush as in Fig. 3. Then split the waste piece into sections to release the plugs as in Fig. 4. To avoid damaging the ends of the plugs use a leather or soft-metal pad when tapping them into counterbored screw holes as in Figs. 1 and 5. Plugs made in this way are used to conceal screw and nail heads in boat construction, ranch-type flooring and cabinetwork. When plugs are used to conceal screwheads in ranch-type flooring they can be made from a contrasting wood, such as walnut or birch. Make them full length with a plug cutter, then finish to size as in Figs. 2 to 5 inclusive.

R. Hanscom, Elmhurst, Ill.



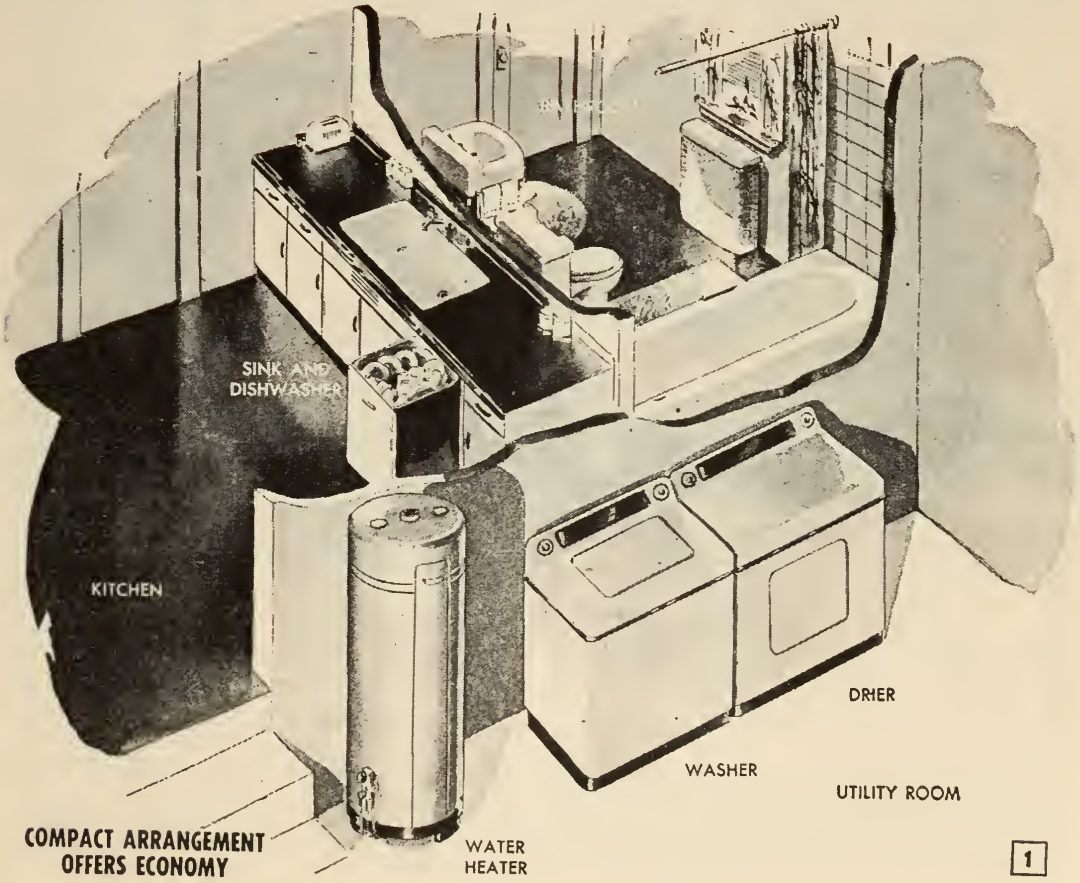
HOW TO PLAN YOUR PLUMBING SYSTEM

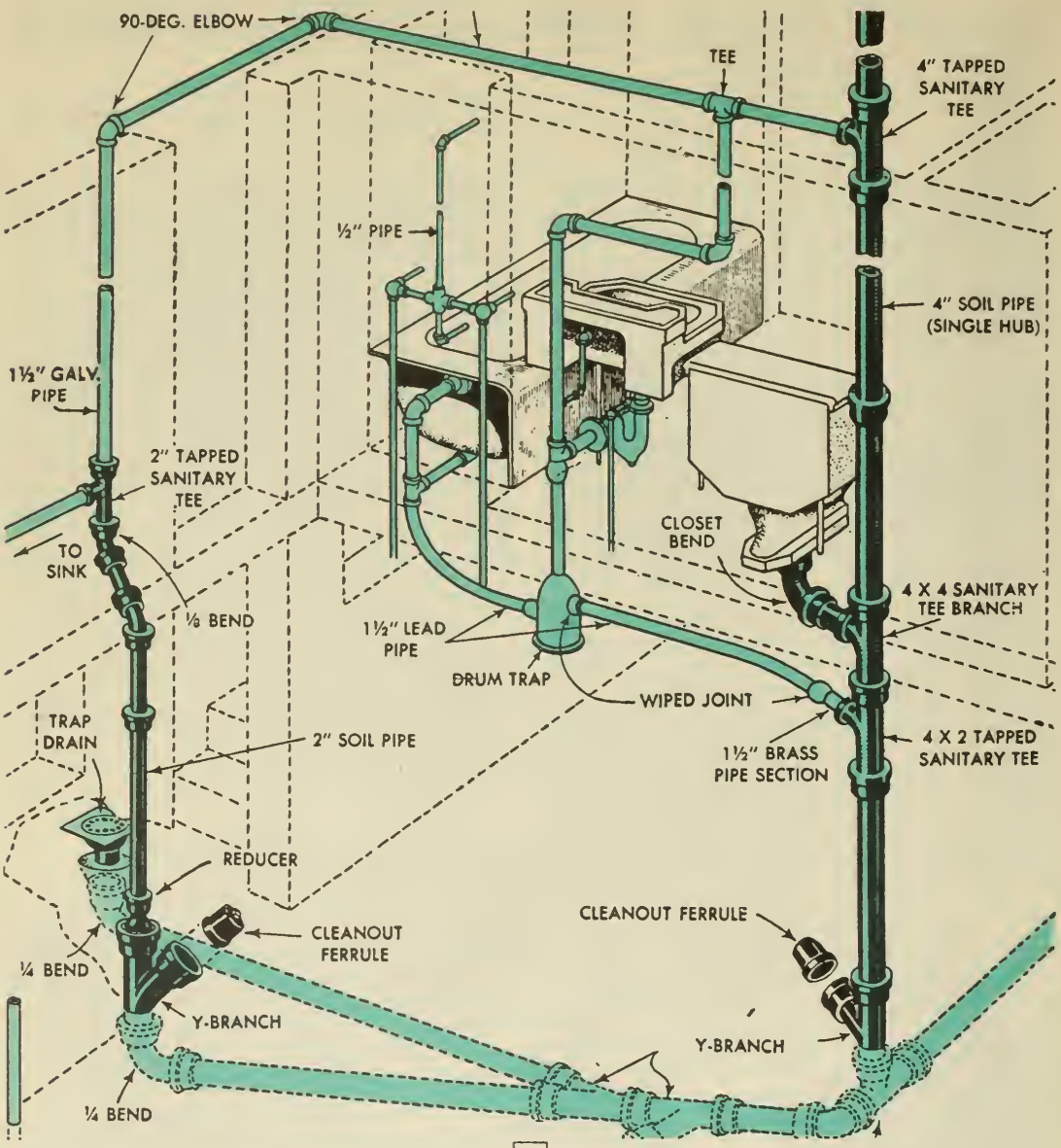
YOU CAN HAVE all the advantages of modern plumbing wherever running water under adequate pressure is available. The first step is careful planning, the second is selecting the right materials and the third is proper installation. The largest portion of a plumbing system is concealed from view and is normally impossible to reach after the walls and partitions are plastered. Fig. 2 shows the extent of the hidden piping of a plumbing system in a small house. Repair or replacement of this piping can be done only at considerable expense. Therefore the pipe, fittings and the workmanship should be of the highest quality.

Basic planning by homeowners: Basic planning in regard to the location of the fixtures, as well as their selection, is a job for the homeowner himself; the details of planning are generally left to an architect, building contractor or plumber. In planning you should consider possible future needs such as an extra bathroom, a basement shower, an outdoor sprinkling system, or in case you live in a rural district, branches to various buildings where water may be required. The installation can be done piecemeal. A layout carefully planned at the beginning makes it possible to do this without discarding, replacing or rearranging previously installed piping and equipment as new parts of the system are added.

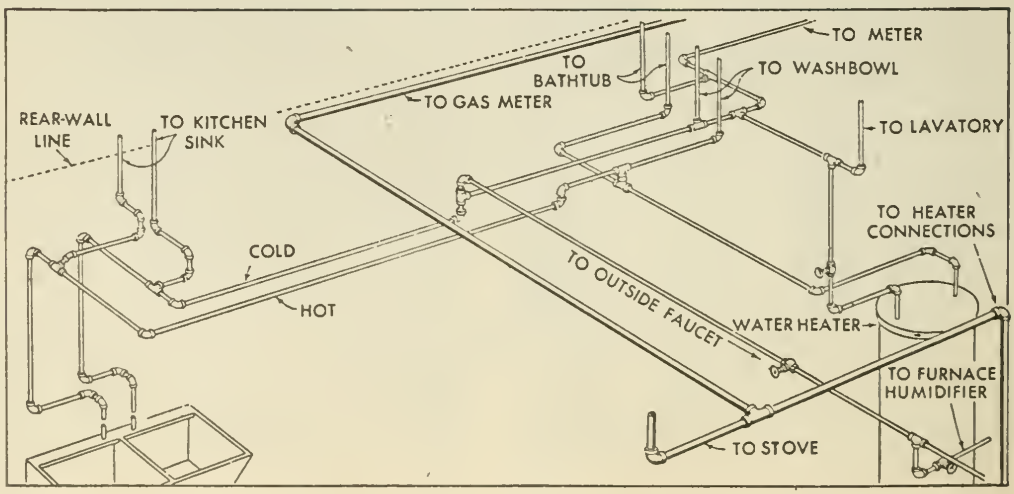
Minimum plumbing for houses: Although home plumbing installations differ according to family requirements, it is generally considered that the minimum plumbing needs of the average small home should include a bathroom equipped with a lavatory, water closet, a bathtub having a shower outlet over it, an adequate kitchen sink, a suitable laundry tub and one or two outside hose connections. A combination sink for dishwashing and laundering is recommended only for very low cost homes.

Economy in new-house plumbing: Much greater flexibility in planning is possible when you are building a house than when you are installing plumbing in an existing




90-DEG. ELBOW
TEE
4" TAPPED SANITARY TEE
½" PIPE
4" SOIL PIPE (SINGLE HUB)
1½" GALV. PIPE
2" TAPPED SANITARY TEE
TO SINK
⅛ BEND
CLOSET BEND
4 X 4 SANITARY TEE BRANCH
1½" LEAD PIPE
DRUM TRAP
WIPED JOINT
TRAP DRAIN
2" SOIL PIPE
1½" BRASS PIPE SECTION
4 X 2 TAPPED SANITARY TEE
REDUCER
CLEANOUT FERRULE
CLEANOUT FERRULE
¼ BEND
Y-BRANCH
Y-BRANCH
¼ BEND

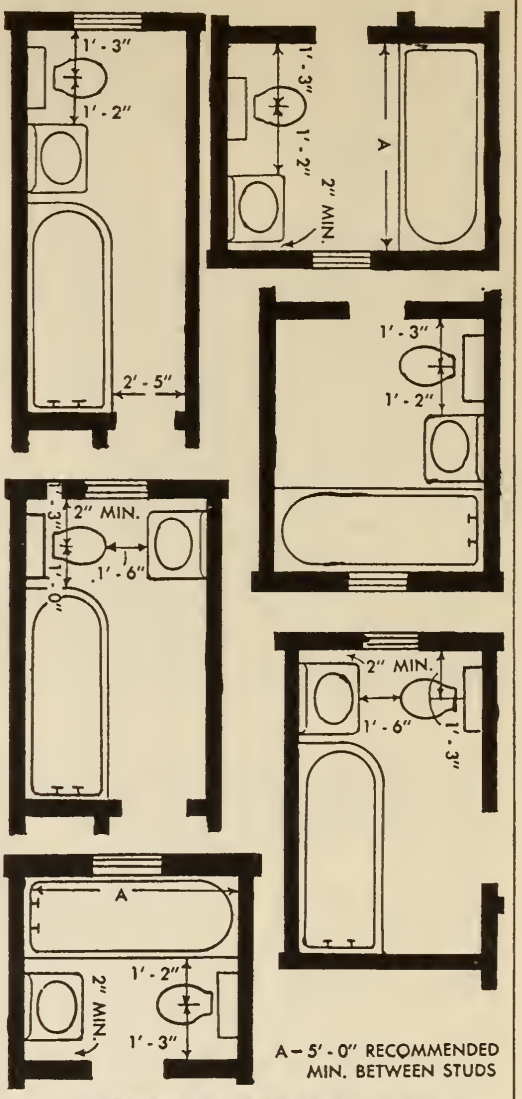
2


TO METER
TO BATHTUB
TO WASHBOWL
TO GAS METER
REAR-WALL LINE
TO KITCHEN SINK
TO LAVATORY
TO HEATER CONNECTIONS
COLD
HOT
TO OUTSIDE FAUCET
WATER HEATER
TO FURNACE HUMIDIFIER
TO STOVE

house. For economy in plumbing, rooms containing plumbing fixtures should be grouped together as much as possible and the piping installed in a common partition. For example, in a one-story basementless house, a minimum amount of material and labor are required if the bathroom fixtures are grouped on one side, and the kitchen sink on the other side of a partition. It is also wise to have this group of fixtures in close proximity to the utility room, as shown in Fig. 1.

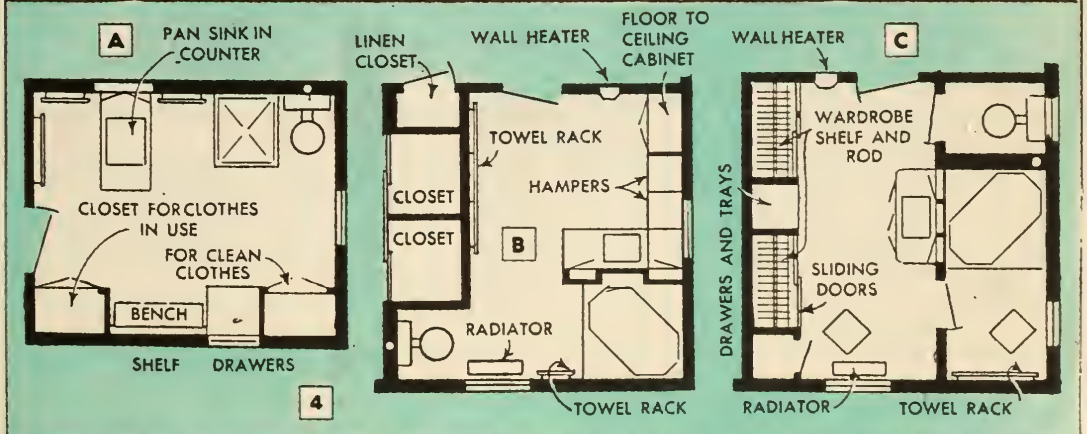
Economy can be effected in the plumbing of a two-story house, such as shown in Figs. 3 and 4, by locating a bathroom directly above the first-floor bathroom and kitchen, with a common wall to enclose vertical pipes. In climates where severe freezing occurs, pipes should not be run in outside walls unless absolutely necessary and then only if the pipes are suitably insulated against freezing. Short hot-water lines supplying groups of fixtures not widely separated have an advantage over long lines in that only a small amount of water need be drawn off at the outlets before hot water becomes available. For longer lines the hot-water pipes should be insulated, which prevents water in them from cooling off quickly.

Bathroom suggestions: Six basic layouts for small and medium-size bathrooms equipped with bathtubs are shown in Fig. 3. The same arrangements are adaptable to larger rooms. Surplus space also can be utilized for cabinets, hampers or closets, or perhaps a counter in which a lavatory is installed. Detail A of Fig. 4 shows a 10 by 12-ft. room remodeled into a convenient bathroom equipped with a shower. Detail B shows a 12 by 12-ft. space used for a bathroom and for two closets of an adjacent bedroom, and detail C shows an alternate arrangement with wardrobe closets opening into the bathroom, in which case the tub and water closet are partitioned off from



SIX BASIC BATHROOM LAYOUTS WITH BATHTUBS SHOWING MINIMUM SPACING REQUIREMENTS

3

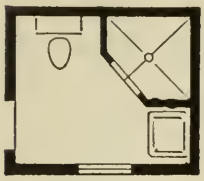


ARRANGEMENT OF PLUMBING FIXTURES AND STORAGE SPACE FOR ROOMS REMODELED TO LARGE BATHROOMS

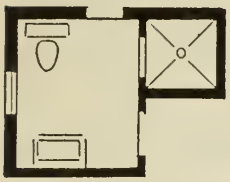
U S Dept. of Agriculture illustration

5

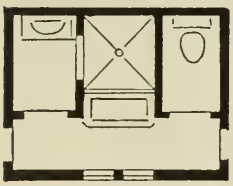
SHOWER STALL USED INSTEAD OF TUB IN SMALL BATHROOM PROVIDES MORE FLOOR SPACE, AND IN THIS CASE USE OF A VANITY-TYPE LAVATORY



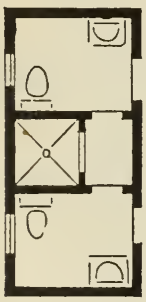
HERE THE USE OF A CORNER SHOWER STALL WITH DOOR AT ANGLE IN CENTER OF ROOM GIVES MOST SPACE AND MAXIMUM CONVENIENCE IN SMALL ROOM



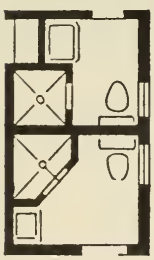
A SMALL BATHROOM CAN BE MADE LARGER BY UTILIZING ADJOINING SPACE SUCH AS A CLOSET FOR THE LOCATION OF A SHOWER STALL



TWO-DOOR ENTRANCE TO THIS BATHROOM GIVES PRIVACY IN THE SHOWER STALL, YET PERMITS SIMULTANEOUS USE OF OTHER FIXTURES



EXAMPLE OF GOOD PLANNING TO GET EQUIVALENT OF TWO BATHROOMS IN SMALL SPACE, A SINGLE SHOWER STALL BEING INSTALLED TO SERVE BOTH

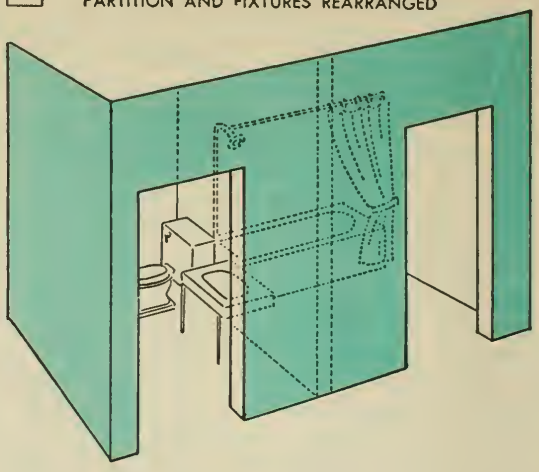


TWO SMALL BATHROOMS REPLACING A SINGLE LARGER BATHROOM WITH TUB, FOR THE GROWING FAMILY. BACK-TO-BACK ARRANGEMENT IS MOST ECONOMICAL

GROUP OF THREE BATHROOMS —A SEPARATE ONE ADJOINING A BEDROOM AND TWO WITH CONNECTING DOOR AND HALL ENTRANCE. INCLUDES TWO SHOWER STALLS AND BATHTUB

Henry Weis Mfg. Co.

6 LARGE BATHROOM DIVIDED BY PARTITION AND FIXTURES REARRANGED



the lavatory. Shower stalls can be substituted for tubs. Seven arrangements for single and grouped bathrooms using shower stalls are shown in Fig. 5. When all the fixtures of a bathroom are arranged along one wall, less piping is needed. However, convenience and comfort should not be sacrificed for a relatively small savings in pipe costs. Fixtures for bathrooms can be obtained in a variety of colors.

If possible, a single bathroom should be located centrally in the house, where it is not necessary to cross another room to enter it. Bath and powder rooms should be located off a passageway where their entrances are not visible. They should not, if possible, open directly into a kitchen, living or dining room.

Adequate ventilation and lighting are essential. Try to arrange a lavatory at right angles to a window for maximum illumination from daylight. A window over a bathtub is not desirable as it is difficult to open and close by reaching over the tub. An extra shower curtain then is necessary to protect the window trim and curtain. A draft also is likely to be felt at times by anyone using the tub. If the window must be located over a fixture, and there is a choice, place it over the water closet so that the sill will come about 4½ or 5 ft. above the floor.

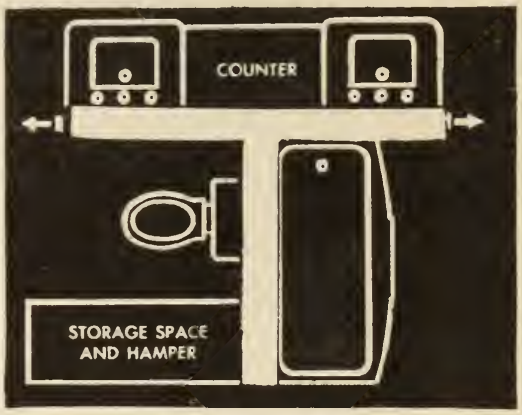
The door may be only 2 ft. wide if necessary. If possible, it should be located so that when opened it will conceal the water closet. The door should swing so that it will not strike anyone at a nearby fixture. If space inside of a bathroom is very limited the door can be swung out instead of in as customary. When fixtures are arranged on one wall, they should be spaced for sufficient elbow room.

A small bathroom is more easily heated than a large one. When a single large bathroom is used frequently by several mem-

Crane Co. photo

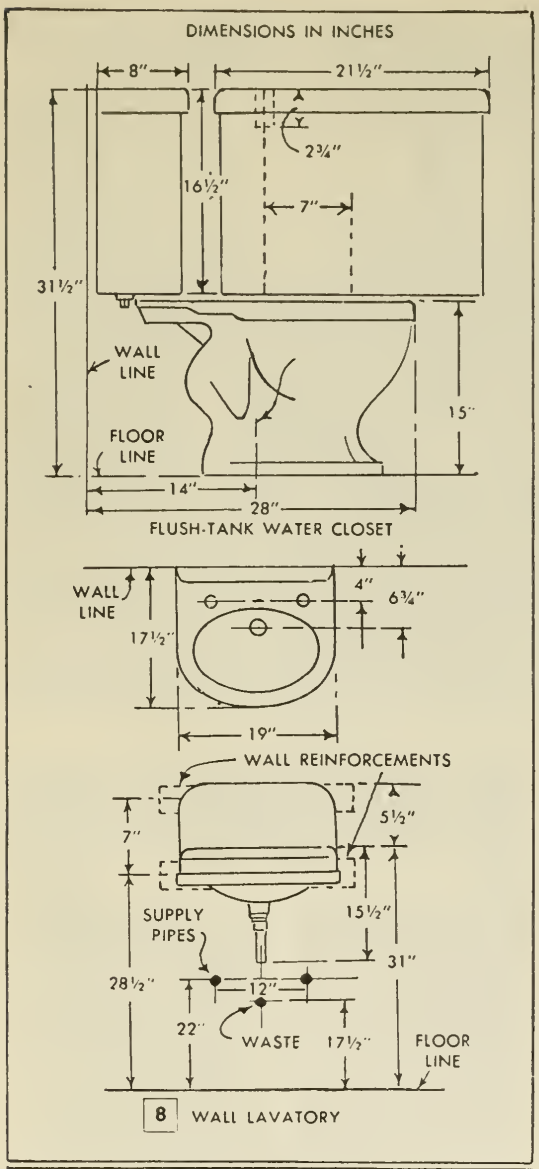
7

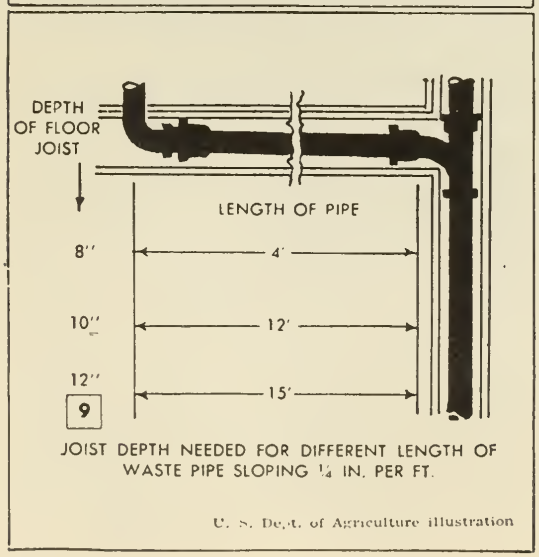
bers of a family, congestion can be relieved by dividing the room by means of a partition as shown in Fig. 6. One part can contain the bathtub or shower; the other the lavatory and water closet. Each is provided with a separate entry. A T-type bathroom, such as shown in Fig. 7, is another practical solution to relieve congestion in a home having only one bathroom. Note that there are two lavatories and a separate shower section. Although ample electric light should be furnished at the lavatory, preferably on either side of the wall cabinet or mirror, above it, no electrical outlets should be located within reach of a person in the bathtub as this involves danger to life.

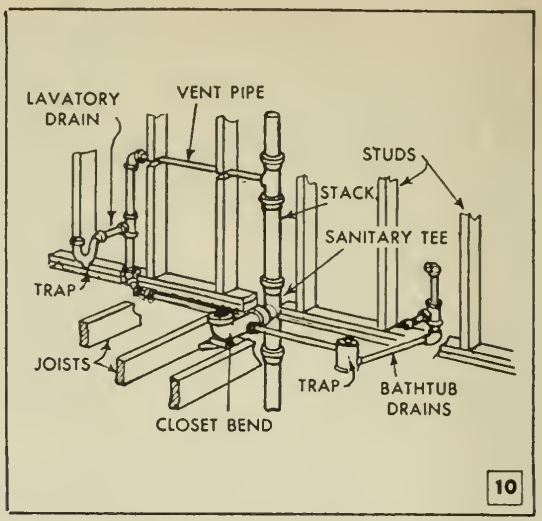


Detailed planning: When a plumbing system is planned in greater detail than the approximate locations of fixtures, it is necessary to determine the arrangement and positioning of the piping. This is done by taking careful measurements in relation to the building construction. Before doing this, however, you should be thoroughly familiar with the method of assembling pipe, where and how to install vents, traps, etc. Also, the installation must conform to your local plumbing ordinance or "code." In the absence of a local code it is best to plan the installation according to the National Plumbing Code. When making your installation be sure to conform to the code and this will eliminate hazards from improperly installed plumbing. If you hire a building contractor or plumber to do the work, even though you may help, it is his responsibility to plan the job according to your specifications, get a plumbing permit, make the installation meet all code requirements and then obtain local approval.

In case you are building a new house, the location of the plumbing fixtures and pipes should be indicated accurately on the plans, depending on how complete they are. Often however, the plumbing is not planned in detail and is left more or less to the discretion of the plumber. Lack of sufficient planning accounts for the frequent need of making expensive alterations by carpenters to provide space for the plumbing lines; also this negligence accounts for the incorrect installation of some plumbing systems. Therefore, planning the details beforehand often means a considerable saving of time and money.



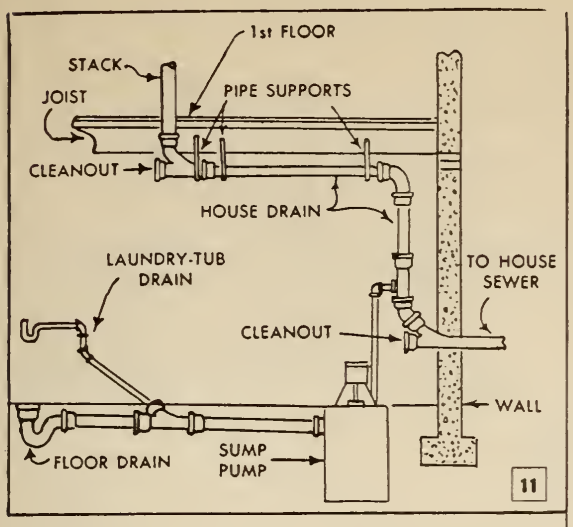




Since both water-supply and drainage systems connect to the fixtures, both systems should be planned carefully and coordinated in their relation to each other. You should either have the plumbing fixtures on hand when planning or have all the dimensions pertaining to them. The exact position of the supply and waste pipes, as well as the location of the fixtures, can then be accurately determined. Manufacturer's "roughing-in" sheets that accompany fixtures, and are sometimes available separately, supply this necessary dimensional data. Fig. 8 shows typical drawings and dimensions of roughing-in sheets.

Stack location: Since the soil and vent stack is the least "flexible" part of a plumbing system, and should be installed as close as possible to water closets and also centrally among other fixtures that it serves, its location should be determined first. The soil stack runs vertically and as nearly straight as possible from the house drain into which it discharges, and continues up through the roof for venting. It must be planned to avoid doors, heating ducts or pipes, girders under the first floor, electric-wiring outlets and dormers on the roof. The partition enclosing a stack must be wider than usual to provide sufficient space. Wider studs than usual can be used or regular ones furred out. The added space required varies with the size of the stack. It must be slightly greater than the outside diameter of the pipe at the hubs.

It may be necessary to choose a different location for water closets than originally planned to obtain better stack location. If possible, the horizontal lengths of soil pipe from the stack to the water closets should be run parallel to joists instead of across them. This saves cutting joists and installing extra floor framing. The width of the joists will limit the distance that a soil pipe at proper slope can be concealed between

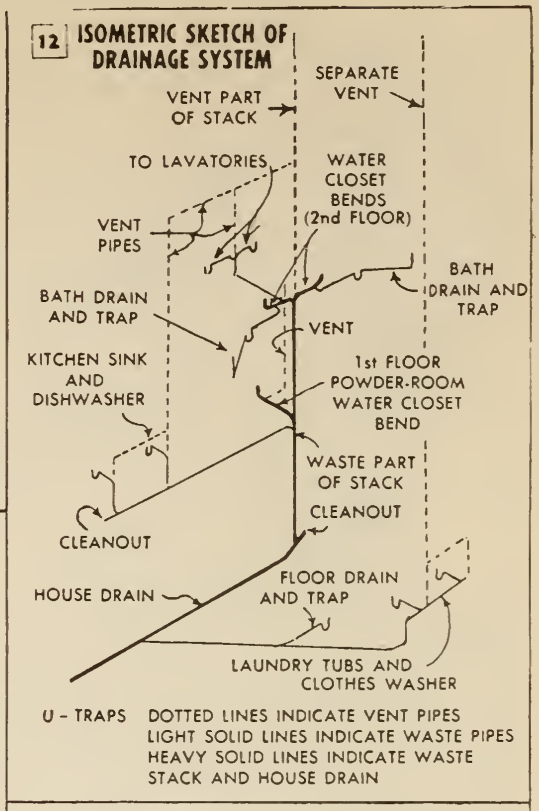


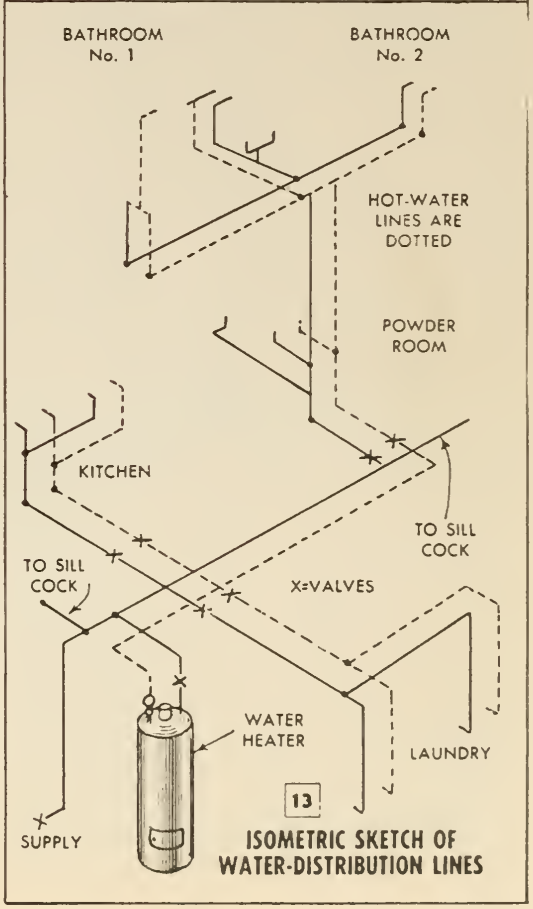
stack and water closet as shown in Fig. 9.

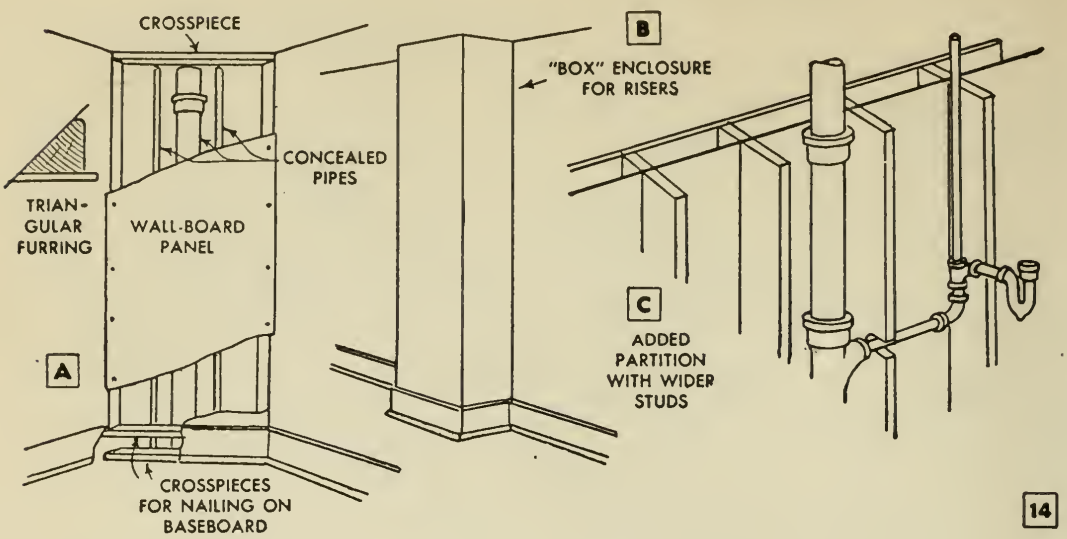
After the stack location has been selected check the house construction, taking measurements if necessary to see whether the stack can be so installed. Also determine the position of the waste pipes, traps and the connections to stack and fixtures. Fig. 10 shows an arrangement which applies to a one-story house or to the second floor of a two-story house. Also determine the location of extra vents or waste stacks if needed.

Position of house drain: The house drain runs horizontally from the stack to the house sewer, generally at a slope of ¼ in. per ft., and connects to the latter about 5 ft. outside of the foundation wall. The house drain may be suspended from the basement ceiling, as in Fig. 11, or it may be run under the basement floor. The latter is usually preferred as it conceals the pipe and provides more headroom in the basement. In basementless houses, it is hung from joists above the crawl space or buried in a trench. In case the outlet of the house drain must be above the basement floor, as for example when a lower level would necessitate burying a septic tank too deep, or when a street sewer is higher than the basement floor, a sump pump is used to raise the waste from the floor drain and laundry tubs up to the house-drain level as in Fig. 11. The house drain should take the shortest straight path to the house sewer, avoiding unnecessary bends. Floor drain and tub waste connections must be carefully determined also. Cleanout plugs are provided to simplify clearing away obstructions if they should occur. These are located at the base of the stack or wherever the house drain changes in direction more than 45 deg. A cleanout should be provided for every 50 ft. of horizontal pipe.

Layout sketches: Next, make an isometric sketch of the drainage system like the







one shown in Fig. 12, entering all the connections and dimensions. This sketch provides a basis for ordering the material needed and also serves as a guide when making the installation. Such a sketch is easily made after ruling a number of light or colored guide lines at two opposite angles of about 30 deg., on which heavy lines to represent horizontal pipes are drawn. The vertical pipes are entered on the sketch by making vertical lines. Only one line is made for each pipe to indicate its center. Upturned "hooks" at waste pipes represent traps. Dotted lines indicate vent pipes.

A similar sketch is made of the water-supply and distribution system, Fig. 13, which you plan next. Because of the smaller size of pipes used, there is more flexibility of installation, although the connections to fixtures must be made at predetermined positions. In general the piping lines are grouped in the same or adjacent partitions if possible. The water-system sketch may have dots to indicate fittings in the pipe lines and X-marks to indicate valves. The sketch enables you to show horizontal pipes extending in any of four directions from vertical pipes and also show which way the openings face.

Before engaging in detailed planning of a plumbing system, it is best to become thoroughly familiar with installation of drainage lines and water-supply lines, some of the requirements covered may influence details of planning. Although you sketch the two systems separately, they should be planned in relation to each other so there will be no trouble of pipe interference.

Adding plumbing to existing houses: Concealed plumbing in existing homes is more difficult to install and also more costly than in homes being built, but it is generally preferred in spite of its added cost. It will be necessary, however, to open floors and remove plaster. The best position of the stack is determined first. Location of bathroom and other plumbing fixtures will be influenced by stack location and vice versa. If a new wall is to be built to enclose the stack and water pipes, be sure to allow sufficient space. You can use 6-in. studs (actually 5½ in. wide) for a partition to enclose 3-in. soil pipe, if this size of stack is permitted in your locality. Sometimes a linen or clothes closet can be used to advantage for concealment of the stack and pipes. Another method is to group the pipes in a corner and conceal them with a panel of wallboard or plasterboard covered with plaster, which is joined to plaster on adjoining walls. Such an arrangement is shown in detail A of Fig. 14. Where pipes cannot be located in a corner they can be boxed in as in detail B. It is also possible to add a wider partition to one that is too narrow in order to accommodate the soil stack as shown in detail C. As plumbing fixtures are heavy, make sure that the floor joists are large enough to take the weight. Extra joists may be required.

Copper tubing used for water lines can be "snaked" through a closed partition, however, after first making sure that there are no obstructions. In such cases the partition is usually opened at the baseboard level of the first and second floors . In cases where minor obstructions in partitions prevent the use of rigid pipe, copper tubing is the best solution as it can readily be bent around such obstructions. However, rigid pipes can sometimes be installed in a partition by lowering them through the roof.

Installing or Replacing

SMALL WATER SYSTEMS

Careful planning and proper installation are vital for efficient and convenient operation

By Enno R. Haan

AS THE GREATER PORTION of a plumbing system usually is concealed, careful planning, good workmanship and the best quality of materials will minimize maintenance troubles, including possible replacement of pipe at considerable expense and inconvenience.

Adequate Pipe Size

Increased water demands occasioned by modern conveniences such as automatic dish and clothes washers, water softeners, air conditioners that use water for cooling and extra showers frequently tax a system beyond its capacity. Most plumbing complaints, outside those easily cured by minor repairs, generally are caused by undersize piping. Piping that is too small can cause whistling noises due to high water velocity, aggravate water hammer and permit backflow. The latter condition exists when undersize pipes restrict the flow of water so that if a faucet on the first floor of a house is opened, there is not enough volume of water to flow up to a faucet on the second floor. Often a partial vacuum will result in the piping on the second floor. Should a spray hose be connected to a faucet and dropped in the bottom of a filled bathtub, opening the faucet will permit the vacuum in the lines to siphon the water from the tub and discharge it through an open faucet on the floor below. The remedy for this condition is to replace the existing undersize piping.

Piping that was of adequate size originally, may become undersize because of lime and corrosion deposits inside. Another cause of insufficient flow and pressure in water pipe, which has the same effect as undersize pipe, is too many changes of direction in pipelines, involving an excessive number of fittings and often the wrong kind of valves. To determine the proper size to use is comparatively easy by following the

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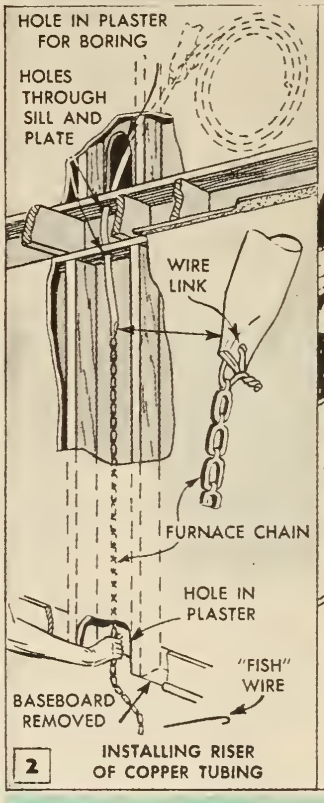

2 INSTALLING RISER OF COPPER TUBING

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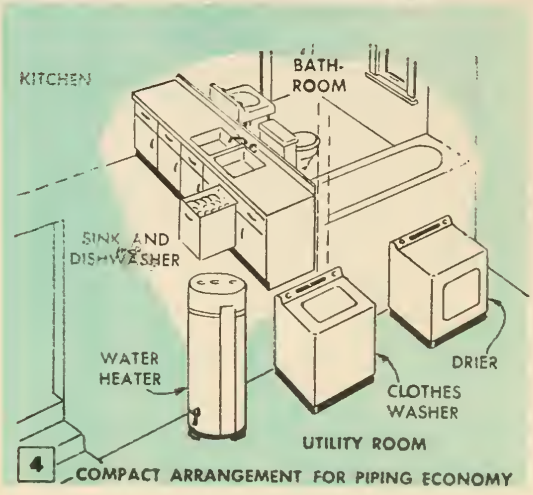


4 COMPACT ARRANGEMENT FOR PIPING ECONOMY

A WATER DEMAND

A—Rate of flow in gallons per minute (g.p.m.) per fixture
B—Estimated peak demand for each branch under conditions of simultaneous use

FIXTURE	A	B
2 sill cocks	10	5
Laundry tub	8	
Clothes washer	8	8
Kitchen sink	7.5	
Dishwasher	7.5	7.5
1st floor lavatory	5	
water closet*	3	
Bathroom No. 1		
lavatory	5	
water closet*	3	
shower	8	8
Bathroom No. 2		
lavatory	5	
water closet*	3	
bath tub	10	10
Total flow of all fixtures	83	
Peak demand for house		38.5

*Tank-type water closets

B FLOW RATE AND REQUIRED PRESSURE FOR COMMON FIXTURES

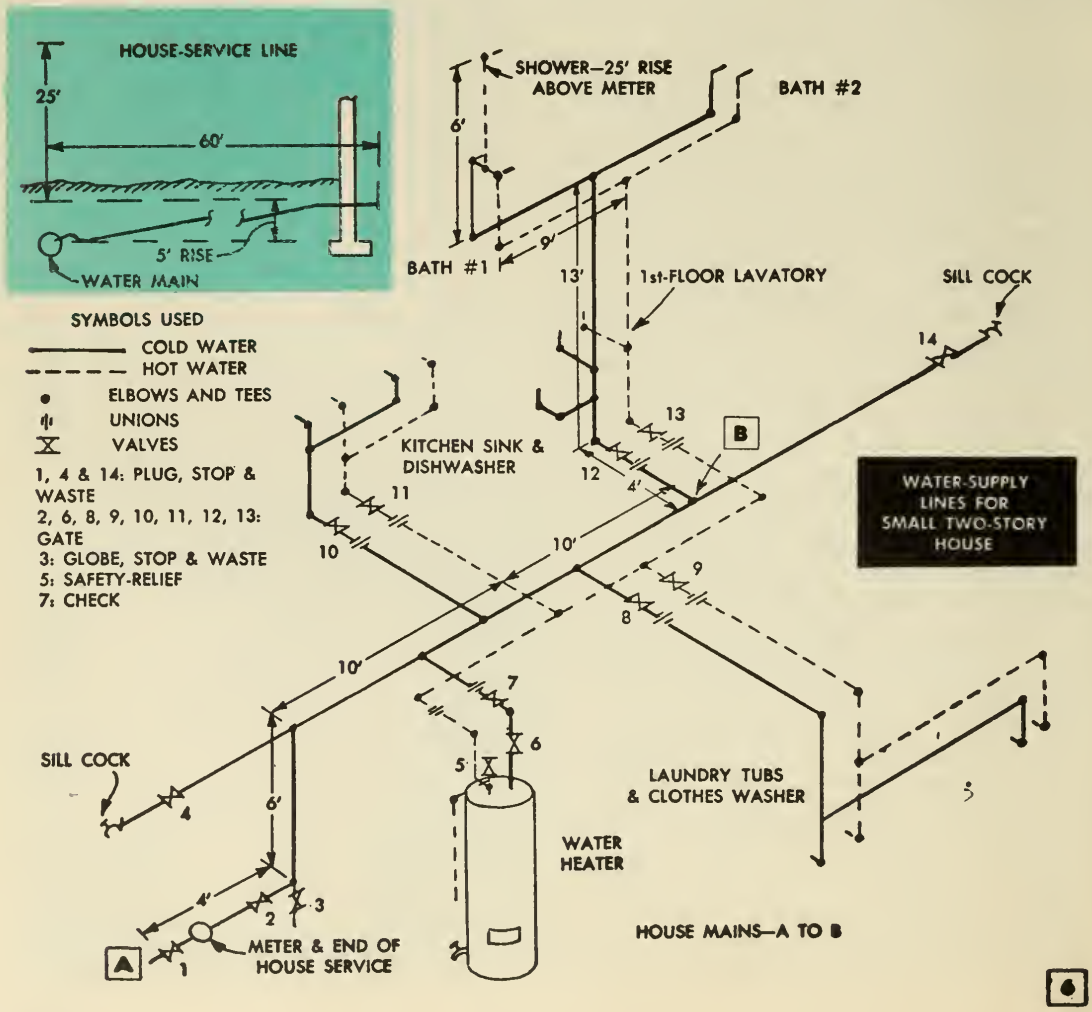
FIXTURE	G.P.M.	P.S.I.*
Lavatory	5	8
Bath tub	10	5
Shower	8	5
Flush-tank water closet	3	12
Flush-valve water closet	15 - 40+	10 - 20+
Sill cock and 50 ft. hose	5	30

* Flow pressure per sq. in. at entrance
+ Due to design variations

C APPROX. RESISTANCE TO FLOW OF THREADED FITTINGS, ETC., IN EQUIVALENT FOOT VALUES OF SAME-SIZE PIPE

FITTING OR DEVICE	PIPE SIZE OF FITTINGS				
	½	¾	1	1¼	1½
90° elbow	0.9	1.3	1.8	2.2	2.7
45° elbow	0.6	0.9	1.2	1.5	1.8
Tee, side to end or reverse	2.2	3.4	4.4	5.5	6.7
Tee, end to end	0.7	1 1	1.5	1.8	2.2
Union or coupling	0.6	0.8	0.9	1.2	1.5
Globe valve	10.0	15.0	20.0	25.0	30.0
Angle valve	5.0	7.0	10.0	12.0	15.0
Gate valve	0.4	0.5	0.7	0.9	1 1
Swing check valve			3-20		
Vertical check valve			10-26		
H.w. tank, vert. 30-gal.		17.0			
H.w. tank, horiz. 30-gal.		5.0			
Water meter		14.0			

Water softener equals 50 to 200 ft. (if unknown use 125) 5



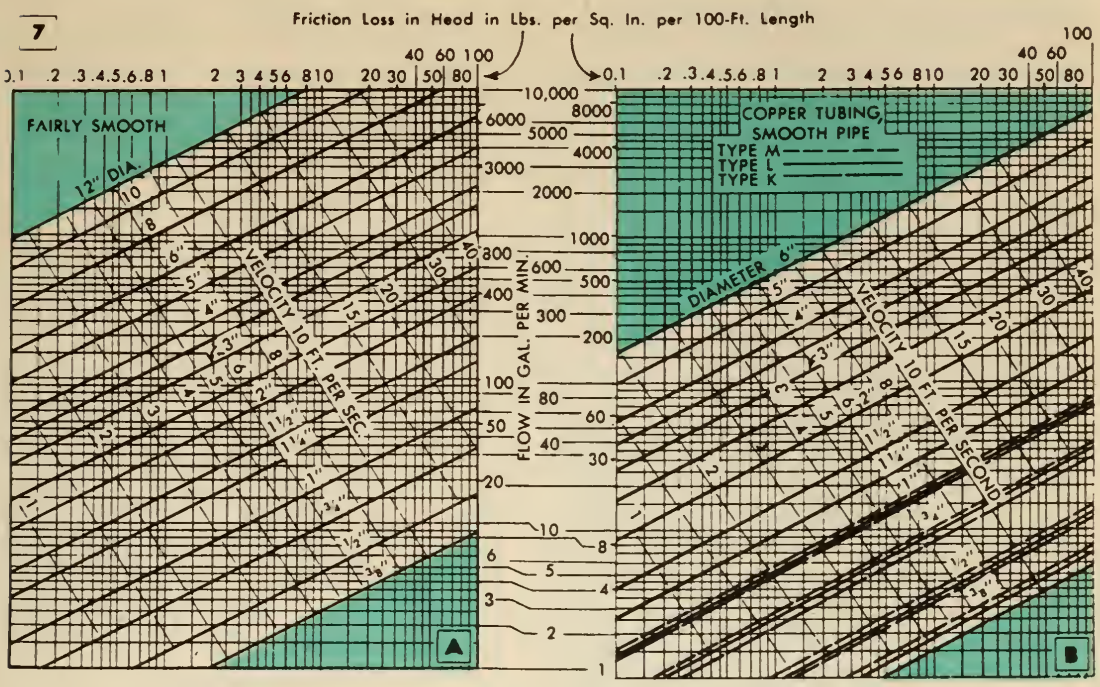


Table C — STEPS OF PROCEDURE

1. Multiply rise by .43 (weight of water 1 ft. high having a cross section of 1 sq. in.) This gives loss of pressure due to rise.	EXAMPLE (Refers to drawing and water-demand list) Object: To find required size of house-service line. 30 x .43=12.90
2. Add 10 to finding of step 1. (10 is average minimum p.s.i. pressure for satisfactory flow at top outlet, not including a flush-valve type of water closet.	12.90+10=22.90
3. Find length of pipe from water source to highest and farthest outlet. (If water softener is to be used, add its pipe-equivalent resistance also. Table C. Fig. 5, when size of house service is figured.)	60+4+6+10+10+4+13+9+6=122 ft.
4. Subtract finding of step 2 from pressure at water source. Multiply result by 100 and divide by the finding of step 3. This gives approximate pressure loss (average) per 100 ft. of pipe, caused by friction.	Assume pressure at water main is 50 p.s.i. $\frac{(50-22.90) \times 100}{122}=22$
5. Locate finding of step 4 on or between vertical lines of Chart A or B, Fig. 7 (depending on pipe type). Locate peak demand on or between horizontal lines. If intersection coincides with, or is very close to a diagonal line, this line indicates proper pipe size to use. If intersection comes between diagonal lines, use next higher one.	Galvanized wrought-iron pipe is used. Refer to Chart A, Fig. 7. Locate 22 with vertical lines and 42 with horizontal lines. Intersection shows size pipe to use is 1¼ in.

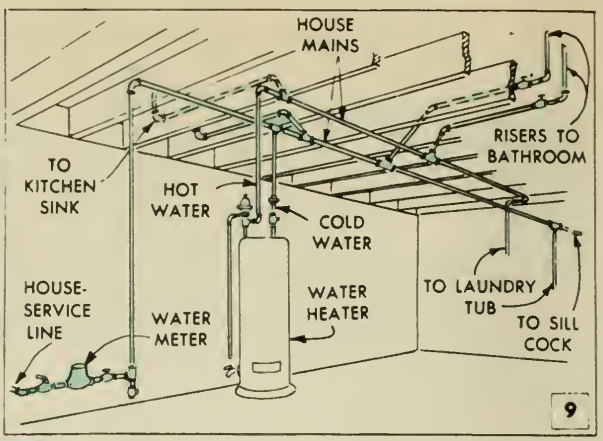
procedure given in table C, Fig. 7. Information from the tables in Fig. 5 is used to determine factors that can be interpreted on chart A or B in Fig. 7.

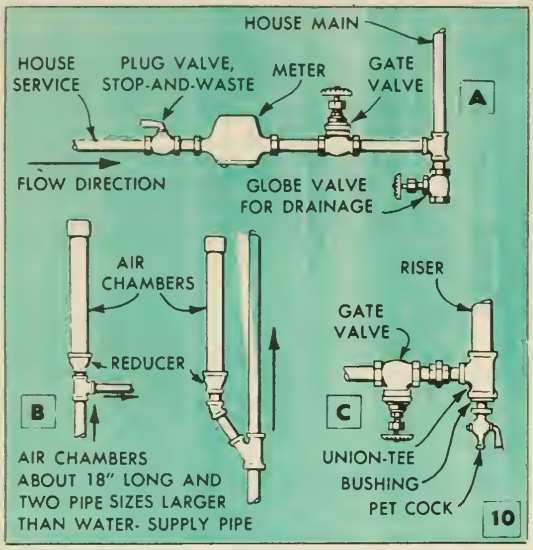
Solving Installation Problems

Installing water lines in an existing house usually involves some difficulties. Where concealment of piping in an unobstructed partition is desired, one method is to use copper tubing, Figs. 1 and 2. When rigid pipe is used it can be cut in lengths of about 6 ft. and passed up through a partition from the basement, Fig. 3. Each length is screwed to another length by means of a pipe coupling. A cap is screwed to the upper end of the first length to protect the threads and keep out debris. To avoid removing more plaster than necessary when these methods cannot be followed, risers sometimes are run through closets where they are not conspicuous. Or, they are run up in a corner of a room and concealed with a panel. Cold-water lines in such locations should be insulated to prevent them from sweating when the warm air in the house contacts the cold pipe.

Short Pipelines

For economy and efficiency, pipelines should be as short as possible. Often risers that supply appliances in adjacent rooms, Fig. 4, can be run through a common partition. If hot-water lines are short, only a





small amount of water need be wasted before hot water is available.

Where to Insulate Pipes

Insulation on hot-water lines, Fig. 8, prevents losses from heat radiation, prevents warming of adjacent cold-water pipes and makes hot water available quicker in frequently used lines. Usually hot and cold-water lines run parallel but not closer than 6 in. Do not install water pipes in outside walls unless absolutely necessary and then only if they are adequately insulated against freezing or, in warm climates, against heating. Use waterproof, antisweat insulation on cold-water pipes where water is likely to drip on plaster, furniture or tools, or where it can collect at the base of risers and cause rotting of a sill.

House-Service Line

The supply line from the water main to the house generally is buried 4 ft. underground to protect it from freezing and mechanical injury. It should be run as straight as possible, sloping toward the water main for drainage. It should never pass underneath a sewer line, it should be laid at least 12 in. above the top of the latter—always on compact, undisturbed earth. Generally, galvanized, wrought-iron pipe is used, although copper is more durable and is required by some building codes. The line should not be smaller than ¾ in. A plug-type, stop-and-waste valve often is installed at the house end.

House Mains

These lines, shown in Figs. 6 and 9, start at the service-line entrance and supply all branch lines. Horizontal lengths are supported at 5 to 8-ft. intervals, securely but not rigidly. A gate valve for shut-off purposes and a globe valve for drainage are installed as shown in detail A, Fig. 10. Pipe must have a slight slope for drainage, without sags, pockets and U-sections to trap water. Generally it is best to have the house mains the same size as the house-supply line. Pipe to a water heater or softener should not be less than ¾ in.

Branch Lines

Use gate valves to shut off branches individually. Globe valves are used only if there is surplus pressure, as they introduce considerable resistance to water flow. Pipes supplying two or more fixtures should not be less than ¾ in., and those to individual fixtures ½ in., although ⅜-in. pipe often is used for short runs to home lavatories or toilet flush tanks.

Air Chambers

Air chambers, which eliminate or reduce water hammer, are shown in details B and C, Fig. 10. For best results, air chambers in average home-plumbing systems should be about 18 in. long and two pipe sizes larger than the supply pipes to which they connect. Periodic renewal of the air which gradually is absorbed by the water compressing it, is done by "bleeding" the line. A drain petcock at each riser, detail C, permits this without shutting off the entire system. ★ ★ ★

PIPE FITTING

Do you want to replace a section of water pipe, change the location of a hot-water tank, or install a new plumbing fixture? Often you can save time and money by doing these simple plumbing jobs yourself. All you need are a few inexpensive tools and a knowledge of the essentials of pipe-fitting practice. It's easy when you know the right way to measure pipe and how to cut, thread and assemble it.

Correct measurements: Center-to-center measurements, which are necessary to lay out the job, are determined as shown in Fig. 1. The actual pipe lengths must be shorter than the center-to-center dimensions to allow for fittings and for the portion of the pipe that enters them. To determine exact lengths, subtract dimension A (center-to-face distance) of fittings from the center-to-center dimensions. Then add dimension C, Fig. 2.

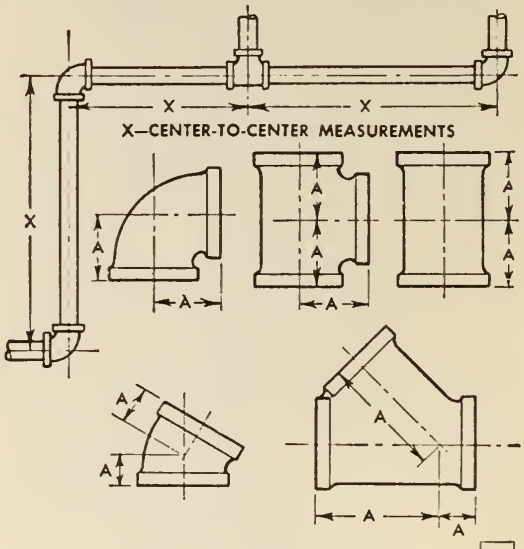
The thread for a 1-in. pipe is not 1-in. outside diameter, as in other forms of thread. In piping, a 1-in. pipe has a nominal inside diameter of 1-in. with an outside diameter of 1.315 in. Another distinguishing difference between pipe threads and other forms of threads is that there is a ¾-in.-per-ft. taper in the diameter of the thread instead of a uniform diameter.

In modern pipe fitting, however, many materials are used, including copper, cast iron, wrought iron, etc. Copper piping has the advantage of a smooth bore and is easy to fit. The joints can be rapidly made, whether by compression, welding or soldering and the economy of labor costs thus achieved frequently outweighs the extra cost of copper as material. Wrought-iron piping properly protected from rust and corrosion with a coating of zinc is also much in favor, but should not be used in a district where soft water or water of an acid nature is apt to attack these metals.

If the handyman follows a few simple instructions, he should have no difficulty in making satisfactory pipe jointings.

Tools needed: Either of the vises shown in Fig. 6 will do, or you can use a machinists's vise fitted with detachable pipe jaws. You'll need two pipe wrenches for the average home plumbing jobs, an 8-in. and a 10-in. wrench. Using too large a wrench may result in buckling the pipe. The proper size wrenches for various pipe sizes are given in Fig. 6. You'll also need a pipe cutter, a reamer and a die stock with threading dies of the

Jointing and attachment of piping, in either water supply or drainage, depends on the size of the piping and material of which it is made. Small-diameter wrought-iron pipes are usually tapped and joined with a threaded sleeve. Center-to-center measurements, which are necessary to lay out the job, are determined in the diagram of dimensions, below. The thread data is given in Fig. 2



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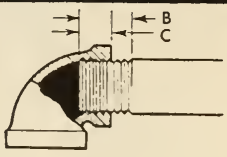
2 CORRECT MEASUREMENTS

THREAD DATA FOR STANDARD-WEIGHT PIPE



Size Pipe	¼"	⅜"	½"	¾"	1"	1¼"	1½"	2"
Thread Lgth. "B"	⅝"	⅝"	13/16"	13/16"	1"	1"	1"	1 1/16"
Thread Screwed Into Fitting "C"	⅜"	7/16"	9/16"	9/16"	11/16"	11/16"	¾"	¾"
No. of Threads Per Inch	18	18	14	14	11½	11½	11½	11½

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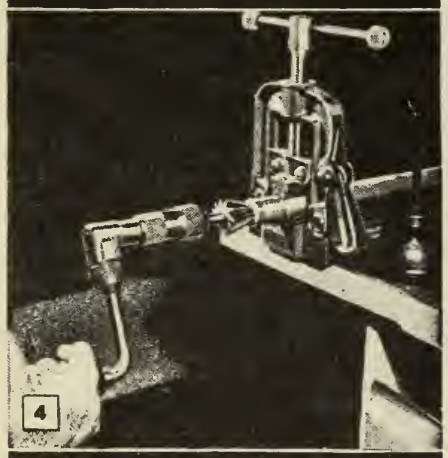
CUTTING



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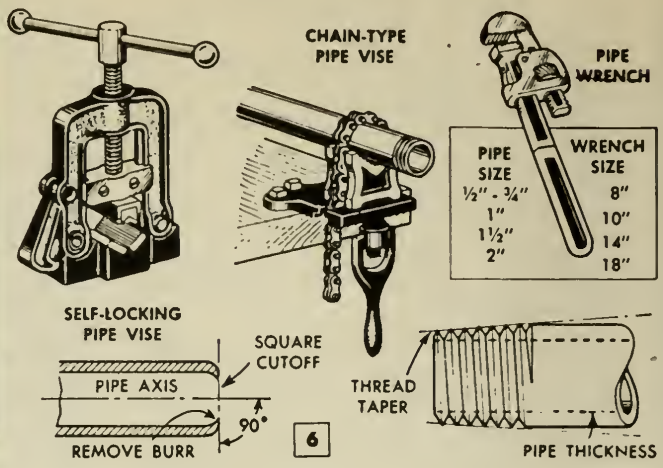
REAMING

5

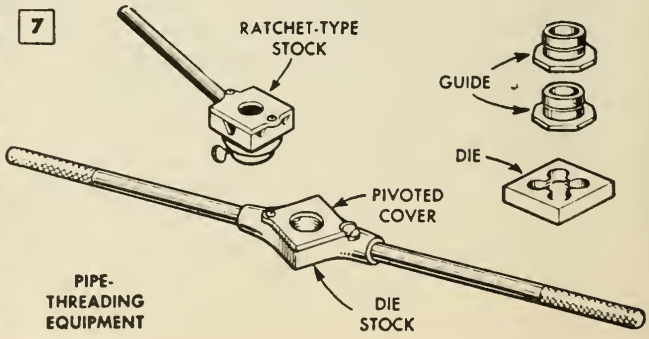
THREADING

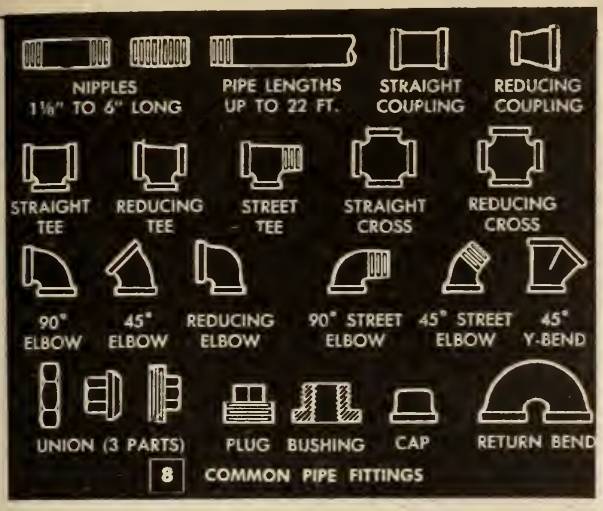


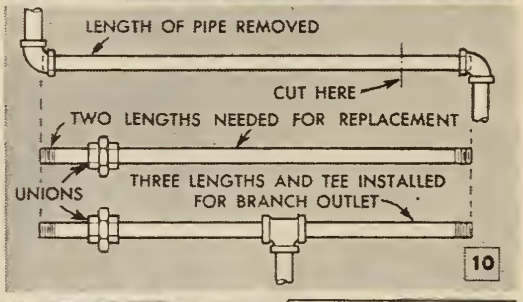
sizes required. Cutting oil is used for lubrication and also to dissipate heat caused by the cutting action of the die.

Cutting off and reaming: Good pipe joints have the ends of the pipe cut off at 90 deg. to the axis, Fig. 6. It's best to use a regular pipe cutter, Fig. 3, rather than a hacksaw. First mark the pipe for cutting, not less than 1 in. from the end. Then grip it in the vise so that the mark extends far enough to permit the cutter and threading tool to clear the bench. Set the cutting wheel on the mark and screw the handle down so that the rollers rest firmly on the pipe. Apply cutting oil and proceed, screwing down the handle a little each time the cutter is rotated. When cut, use a reamer chucked in a carpenter's brace, as in Fig. 4, to remove the burr formed inside the pipe.

Threading: Pipe dies, Figs. 5 and 7, are held in a stock, which is fitted with handles for turning. The ratchet-type stock has only one handle. Ordinary pipe stocks hold dies of several different sizes. There are two types of dies—the solid, non-adjustable type and the split die, which is adjustable for wear and cutting depth. A different die is required for each size of pipe. In a stock-and-die assembly there also is a guide bushing—one for each pipe size within the capacity of the die stock, or one that is adjustable for size. The bushing slips on the pipe first and lines up the die on the end of the pipe. Pipe dies cut tapered threads







as in Fig. 6, and for this reason it is necessary to make sure that the die is placed in the stock so that the largest diameter faces the guide.

After slipping the guide bushing over the pipe, press the die teeth on the pipe slightly while turning the stock slowly to the right. Keep the handle at right angles to the pipe and apply a steady pressure until the die engages. Apply cutting oil liberally. Then start the thread by turning the stock forward a half turn and then back a quarter turn to break the chips. Now turn the stock slowly to avoid excessive heating, and apply cutting oil every two or three turns. Stop threading when the end of the pipe projects slightly beyond the small end of the die. This distance indicates that a thread of approximately standard length (dimension B of Fig. 2) has been cut.

Assembling pipe and fittings: Fig. 8 shows common pipe fittings you will use in an ordinary pipe assembly. Before assembling pipe and fittings, clean the threads with a wire brush to clear them of chips. Then spread pipe-joint compound on the threads of the pipe—never apply it to the internal threads of a fitting as it will be forced inside the pipe and may start an obstruction or taint the drinking water. Turn on a fitting by hand for three or four threads, after which a few more turns with a pipe wrench will draw it up snugly. Tighten the fitting on the pipe while it is still held in the vise, Fig. 9, and before threading the opposite end. This prevents accidental damage to threads and keeps the dirt out. It is not necessary to draw the fitting unduly tight. A moderate pressure on the wrench is sufficient. Excessive wrench pressure may distort the fitting or even strip the threads.

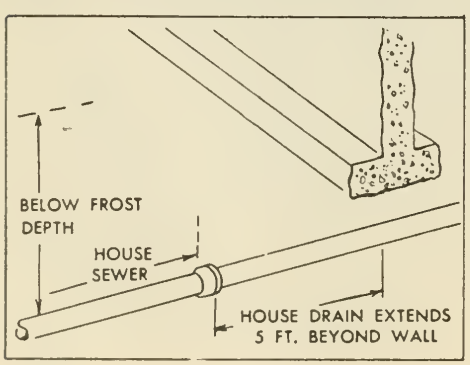
Replacing part of pipe: When a defective pipe is replaced, or when a new branch line is cut into an existing one, Fig. 10, it generally is necessary to saw the latter to permit unscrewing it except, of course, when there's a union to "break" the line. First shut off the water supply and drain the system by opening a faucet. Cut the pipe about 4 in. from a joint, never less if avoidable, and unscrew both pieces. The new section is made up of two lengths and a union, the total length of which should be equal to that of the old pipe. The same method is followed in installing a branch line, three lengths of pipe, a tee and a union being required. When tightening a union, Fig. 11, you'll need two wrenches to prevent the pipe from turning.

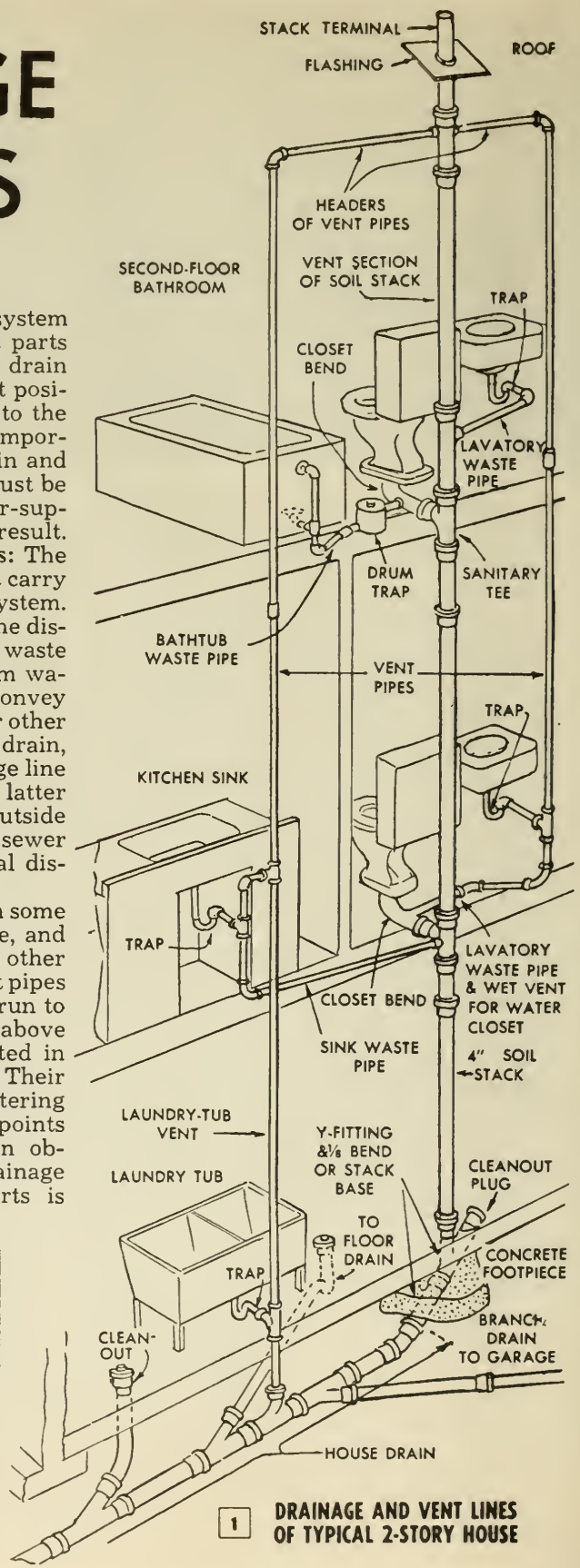
DRAINAGE SYSTEMS

When a complete home-plumbing system is installed, you start with the basic parts of the drainage system—the house drain and the soil stack—because the exact positioning of the stack and its relation to the spacing of the fixtures is of utmost importance. After installing the house drain and soil stack, the waste and vent lines must be coordinated carefully with the water-supply lines so that no interference will result.

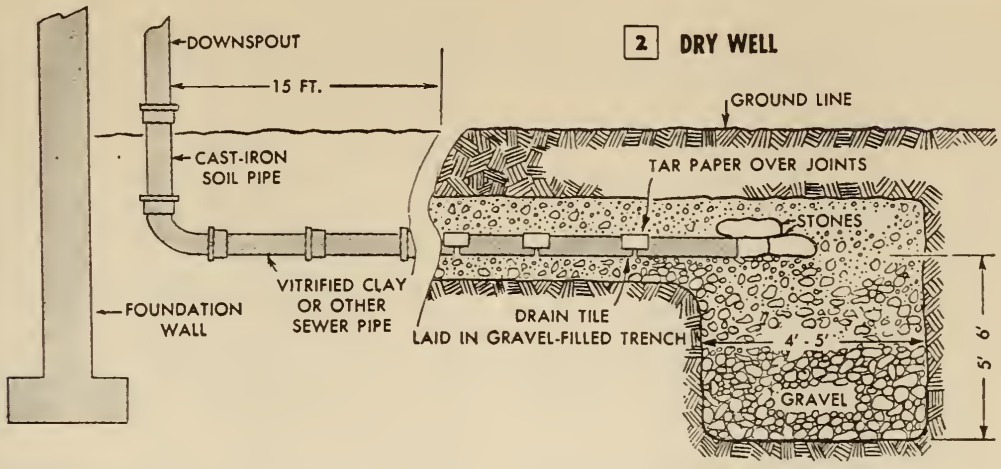
What the drainage system includes: The drainage system consists of pipes that carry waste, and others that ventilate the system. Those carrying liquid waste but not the discharge from water closets are called waste pipes. Those carrying discharges from water closets are called soil pipes. Both convey their contents to the main soil stack or other stack, and these connect to the house drain, which is the lowest horizontal drainage line and connects to the house sewer. The latter starts at a point not less than 5 ft. outside of the house wall and leads to the city sewer or to the septic tank of an individual disposal system.

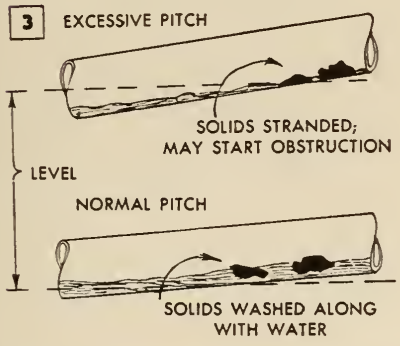
Stacks terminate above the roof. On some the lower portions serve for drainage, and the upper portion for ventilation; other stacks serve for ventilation only. Vent pipes which connect to drainage pipes are run to stacks by means of headers, at points above the highest fixtures. Traps are located in waste and soil lines near fixtures. Their purpose is to keep sewer gas from entering a building. Cleanout plugs at various points permit rodding drainage lines when obstructions occur. A typical home-drainage system comprising all of these parts is shown in Fig. 1.





1 DRAINAGE AND VENT LINES OF TYPICAL 2-STORY HOUSE





Kinds of drainage systems: A system used only to convey drainage from plumbing fixtures is called a sanitary system. A combination system also admits storm water. In many cities separate sanitary and storm-water drainage systems are required, each leading to a separate sanitary and storm-water sewer. The reason is that storm water in sewage is not desired where the latter is handled by a modern sewage-treatment plant. Storm water should never be emptied into a septic tank of an individual disposal system as it floods the tank and interferes with its operation. Storm water may lead to a dry well, as shown in Fig. 2, or to some other point of disposal. The discharge of storm water should be at least 50 ft. from any well, 20 ft. from an individual disposal field of sewage and at least 15 ft. from the house.

Pipe and fittings for drainage lines: Check with your local code concerning the kind of piping permitted for soil, waste and vent lines. Above-ground piping for soil and waste lines should be cast-iron, galvanized wrought iron or steel, lead, brass or copper. Vent pipes may be of these materials but asbestos-cement or bituminized-fiber pipe can be used often. For underground lines inside of a building, cast-iron pipe of the hub-and-spigot type is generally used, although galvanized wrought-iron or steel, lead and copper pipe may be permitted also. Where threaded joints are approved for underground use, they should be coated with asphalt enamel and wrapped with a suitable waterproof material. Storm drains and house sewers may be cast iron, copper, vitrified clay, concrete, bituminized fiber or asbestos cement.

Threaded fittings should be of the recessed drainage type, although ordinary cast-iron fittings may be used on vent pipes. Long-radius fittings are used in drainage lines wherever possible to make gradual changes of direction, particularly in horizontal lines. Any fitting that has an enlargement, chamber or recess with a ledge, shoulder or reduction of pipe area, which can obstruct the drainage flow, should not be used in any drainage line. Increasers in vent stacks and 4 by 3-in. closet bends are not considered restrictive fittings.

Pipe slope or pitch: In drainage lines the flow of liquid is entirely dependent on gravity. For this reason horizontal sections of drainage lines must be given a uniform slope or pitch, which may vary from ⅛ to ½ in. per ft., depending on the pipe size and conditions encountered. The pipe must not have any dips or pockets from which sewage cannot drain out completely. Threaded fittings that connect horizontal pipes to vertical ones have their horizontal openings pitched at the usual slope of ¼ in. per ft. Care must be taken to install them correctly.

For pipes 3 in. or less in diameter, the slope should not be less than ¼ in. per ft. For larger sizes of pipe a slope of not less than ⅛ in. per ft. is sometimes used. However, where conditions necessitate a lesser slope, it should be such as to assure a flow of not less than 2 ft. per second. Excessive slope in horizontal pipes, particularly in large-size pipes, allows solids to remain in the pipe while the water drains away, as in Fig. 3. When a house drain must be in-

stalled above a basement floor, water from the laundry tubs and basement floor drains is pumped up to it with a sump pump.

Importance of correct pipe sizes: For minimum cost as well as efficiency, use the smallest pipe sizes that will adequately carry away sewage. Installing a house drain larger than required does not increase its efficiency as may be supposed, because the flushing action of the water is greatly decreased in a large pipe, leaving solids stranded. See Fig. 3. However, if the pipe is too small it will be overloaded, which may occasion troubles such as basement flooding and back pressure in the drainage pipes.

Basis for finding pipe sizes: The fixture-unit system is used to determine pipe sizes for both drainage and vent lines. The basic unit is 7½ gal. per minute flow (approximately 1 cu. ft.), this being the amount of water discharged from the average type lavatory. Multiples of this unit are used to express the discharge rate of various fixtures as given in Fig. 4, which also gives the minimum sizes of traps for these fixtures. Table B gives fixture-unit discharge of various sizes of pipe openings, and is used for tanks and for fixtures not listed in table A.

Sizing house drain and sewer: To find the size of a sanitary house drain and sewer, you add up the fixture units to get the total load and then refer to table C of Fig. 4. For example, if the total load of a system is found to be 30 fixture-units, reference to the table will show this value to lie between 27 and 216 in the column for ¼-in. slope, which is most generally used. Using the higher value, the proper size pipe would be 4 in. This method is similarly followed for branch lines. Generally the house drain and main stack are the same size. A 3-in. size for these is generally adequate for most small homes. A pipe smaller than 3 in. should not be used to take the discharge of a water closet. No portion of underground drainage branches should be less than 2 in. in diameter.

Sizing combination and storm-water drains: Where storm water can be discharged into a combination house drain or sewer, you allow one fixture unit for each 180 sq. ft. of roof area discharged into the house sewer. This value is based on rainfall rate of 4 in. per hour. The total roof load is added to the fixture-unit load. Arrangement of an outside storm drain is shown in Fig. 5. It should run in the same horizontal plane as the combination drain or sewer and be connected to it with a single Y-fitting at least 10 ft. downstream from any branch to the house drain or from any soil stack. To determine the size of pipe re-

A

A DISCHARGE RATES OF FIXTURES IN FIXTURE UNITS

Type of Fixture	Fixture-Unit Value	Minimum Size of Trap (In.)
One bathroom group consisting of water closet, lavatory and bathtub or shower stall		
for tank-flushed closet	6	
for flush-valve closet	8	
Shower stall		
Bathtub (with or without shower head)	2	2
Lavatory	2-3*	1½ - 2
Kitchen sink	1-2*	1¼ - 1½
Kitchen sink with disposal unit	2	1½
Dishwasher	3	1½
Combination sink and laundry tub	2	1½
Combination sink and laundry tub with disposal unit	3 4	1½ Separate traps 1½
Laundry tub (1 or 2 compartments)	2	1½
Water closet—tank-flushed	4	3
Water closet—flush-valve type	8	3
Floor drain+	1	2

* Depends on size of outlet; see table B
\+ Size determined by area of drainage

B

FIXTURE UNITS AS RELATED TO DRAIN SIZE

Size of Drain or Trap (In.)	Fixture-Unit Value
1¼ or smaller	1
1½	2
2	3
2½	4
3	5
4	6

Note: For a continuous or semicontinuous flow into drainage system, as from a pump, add two fixture units for each gallon per minute of flow

C

MAXIMUM FIXTURE-UNIT LOADS FOR HOUSE DRAINS AND SEWERS, INCLUDING BRANCHES

Pipe Dia.	⅛" Slope	¼" Slope	½" Slope
2"		21	26
2½"		24	31
3"*	20	27	36
4"	180	216	250
5"	390	480	575
6"	700	840	1000

*Not more than two water closets

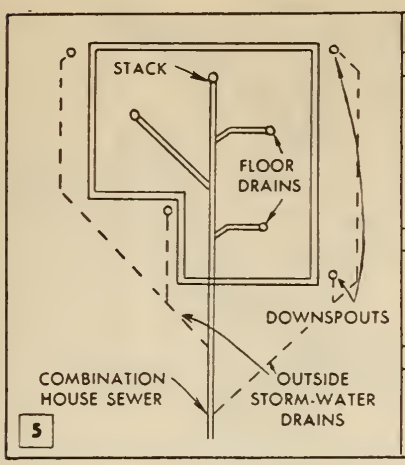
D

MAXIMUM FIXTURE-UNIT LOADS FOR STACK AND HORIZONTAL BRANCHES

Pipe Dia.	Any Horizontal Branch	When Connected to One Stack Not Over 3 Stories High
1¼"	1	2
1½"	3	4
2"	6	10
2½"	12	20
3"*	20	30
4"	160	240
5"	360	540
6"	620	960

* Not more than two water closets

4



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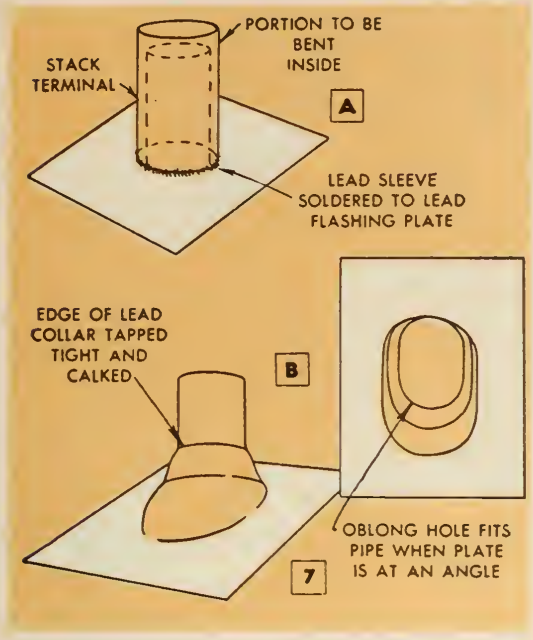
6 SIZE OF HORIZONTAL STORM DRAINS

Diameter (In.)	Roof Area for Drains at Various Slopes			
	Slope in Inch Fractions per Running Foot			
	1/16" Slope	1/8" Slope	1/4" Slope	1/2" Slope
3		822	1160	1644
4		1880	2650	3760
5		3340	4720	6680
6		5350	7550	10,700
Size of Gutters				
3	170	240	340	480
4	360	510	720	1020
5	625	880	1250	1770
6	960	1360	1920	2770
Size of Downspouts	**Roof-Area Capacity**			
2	720			
2½	1300			
3	2200			
4	4600			



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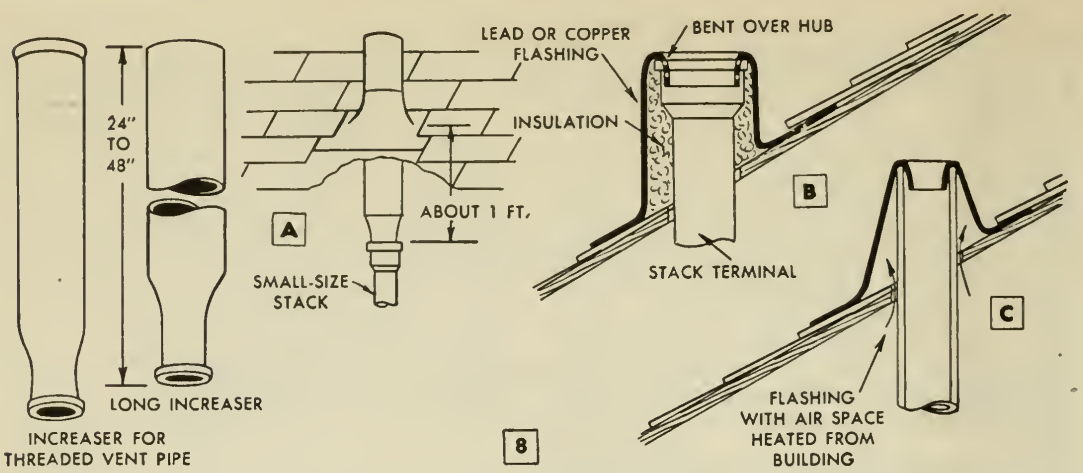
quired for storm drains, gutters and downspouts, refer to the table. Fig. 6.

The soil stack: A soil stack is run up inside of the house generally, being concealed in partitions if possible. It should be centrally located so that the drainage and vent lines serving various fixtures will be of minimum length. It is not advisable to place a stack in an outside wall in climates where temperatures drop to freezing and below, unless the pipe is sufficiently insulated. For the same reason, and also because of appearance, a stack is usually not located outside of a building. In mild climates, however, this can be done to minimize cost, and the stack then can be boxed in for concealment. A soil or waste stack should not be smaller than the largest horizontal branch connected to it, although a 4 by 3-in. water-closet bend is not considered a reduction in pipe size. To determine the proper size of the stack consult table D, Fig. 4.

Stack and vent terminals: A stack passing through a roof should project no less than 6 in. above it. Leakage at the roof is prevented with lead or copper flashing as in details A and B of Fig. 7. Detail A shows vent flashing made by soldering a lead sleeve over a hole cut in a sheet of lead. The angle between the sleeve and sheet should correspond to the roof pitch. The extending end is bent down inside of the pipe. Detail B shows a formed flashing which has an oblong hole so that the flashing can be set at various angles, after which the collar is tapped to a snug fit against the pipe. Shingles go over a flashing sheet at its highest portion, but go under it at the lowest portion.

Provisions must be made to prevent the moisture inside of the stack terminal from freezing and possibly clogging it. This trouble is less likely on 6-in. extensions than on longer ones. Where possibility of such frost closure exists, the terminal should be at least 3 in. in diameter, though 4 in. is preferable. Small vent stacks should be enlarged by means of increasers such as shown in Fig. 8A. They are joined to the stack a foot or so below the roof. Another precaution against frost closure is insulation between the pipe and the flashing as in detail B, or by providing an air space which is heated from the building as in detail C.

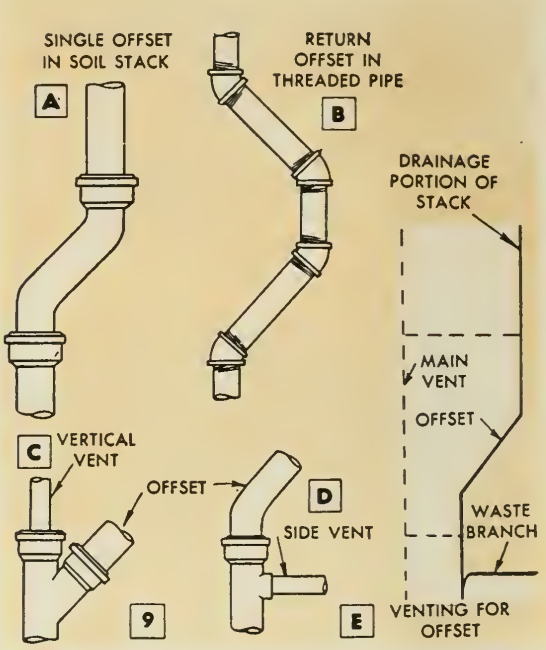
The terminal of a stack or vent pipe should not extend directly beneath a door, window or other ventilating openings of a building. If within 10 ft. of such an opening, the vent should project at least 2 ft. above it. When a vent terminal is extended horizontally through a wall, where permitted, it should be at least 10 ft. from the lot line and the opening should face downward. A vent should never terminate under the overhang of a roof or under any other part of a building.



Offsets in stacks: Sometimes a stack, located advantageously in relation to the fixtures it serves, cannot be run up in a vertical line as is most desirable, owing to building construction or other interference. In such cases it is necessary to go around the obstruction with an offset. A single offset, as in Fig. 9A, introduces less resistance than a return or jumpover offset as shown in detail B. An offset in the drainage portion of a stack, which is 45 deg. or less from the vertical, is sized as a straight stack, but in case a horizontal branch connects within 2 ft. above or below the offset, a relief vent is installed. This may be either a vertical continuation of the lower portion of the stack, detail C, or it may be a side vent connected between the offset and the next lower horizontal branch. See detail D. In either case a vent is also provided above the offset as in detail E.

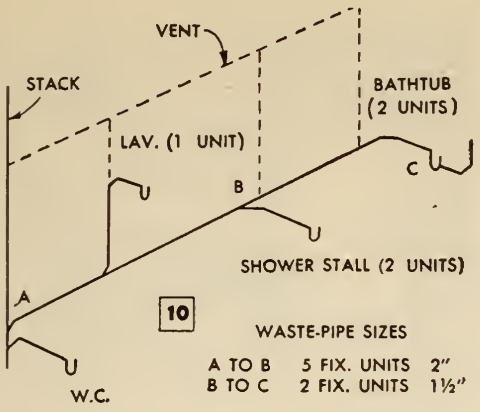
The size of the vents should not be smaller than the main vent or half as large as the stack. If an offset is below the lowest horizontal branch and is greater than 45 deg. from the vertical, its size is determined as for a building drain. A horizontal branch should not connect to a stack within 2 ft. of an offset that is greater than 45 deg. from the vertical. These restrictions do not apply to offsets in the vent portion of a stack.

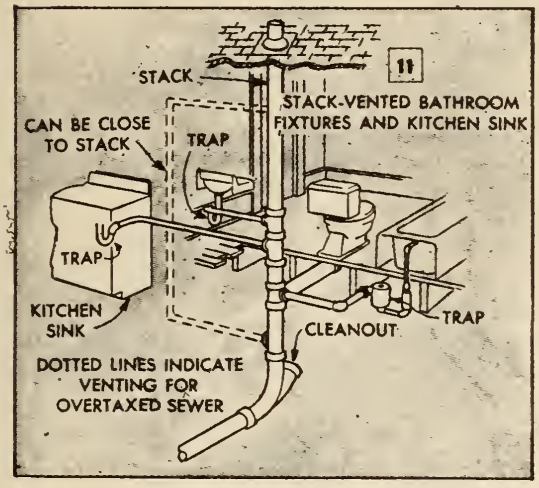
Horizontal drainage branches: A drainage extension to a water closet should be as short as possible and not less than 3 in. in diameter. A cast-iron water-closet bend may be plain or may have tapped openings for connecting waste pipes from fixtures. The size of a waste pipe from an individual fixture is the same as the minimum trap size for the fixture, as given in table A of Fig. 4. Waste pipes serving more than one fixture must be sized according to their fixture-unit load, referring to table D of Fig. 4. An example of sizing horizontal

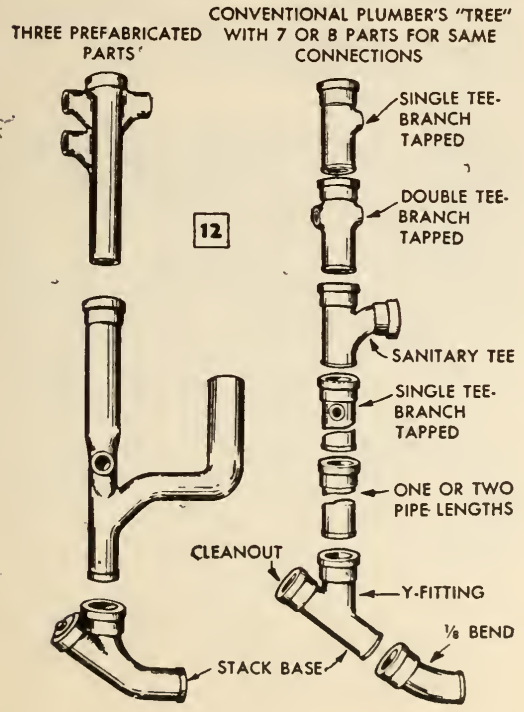


waste pipes of a bathroom group is shown in Fig. 10. Sometimes larger sizes are used for waste pipes serving one or more fixtures, as for instance when the waste pipe is vented from a stack located too far from the fixture to use the normal size. See "Stack venting" discussion that follows.

Purposes of vent pipes: In every plumbing installation the drainage system requires vent pipes for three purposes: (1) To prevent the water seal in fixture traps from being sucked down into the drain pipe either by siphon action or by the momentum of the discharge flow; (2) To prevent back pressure, particularly at lower levels, from forcing water out of traps through the fixtures and (3) to carry away sewer gases to the outside of the house.







Stack venting: The simplest and most economical venting installation for a group of fixtures often used in single-story houses or at the top floor of two-story houses, is "stack-venting," shown in Fig. 11. This is applicable for the following conditions:

(1) The distance from the stack to the fixture traps is limited as specified in the table, Fig. 14. If a fixture is located too far from the stack to vent it through waste pipe of a size based on fixture units, a larger diameter waste pipe that meets the requirements of distance, as given in the table, Fig. 14, can be used.

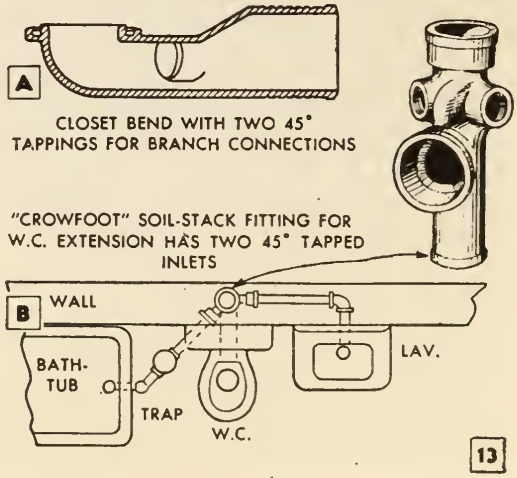
(2) No other water closet or bathtub can discharge into the stack at a higher level.

(3) The total discharge of the fixtures above the water closet and bathtub connections to the stack must not exceed three fixture units.

(4) Each of the fixtures must discharge into the stack independently of others.

When a sink connects to a stack-vented bathroom group at a location where the street sewer occasionally becomes overloaded and floods the house sewer, a relief vent should be connected to the stack below the stack-vented water closet or bathtub, as shown by the dotted lines in Fig. 11.

Prefabricated stack-venting units: Time and money can be saved by using prefabricated drainage units designed for stack venting where their use is permitted by local code. These units are neat and compact and can serve the drainage requirements of kitchen sink, laundry tub and even a bathroom group of fixtures in a one-story house. All of them, of course, should be located close to the stack according to requirements. Various arrangements of fixtures are possible. Fig. 12 shows three prefabricated units that replace seven or eight ordinary pipe lengths and fittings of the usual plumber's "tree," used for the same purpose. The vent portion of the stack in



MAXIMUM DISTANCE OF FIXTURE TRAP FROM VENT

Size of Fixture Drain	Distance in Feet
1¼"	2½
1½"	3½
2"	5
3"	6
4"	10

14

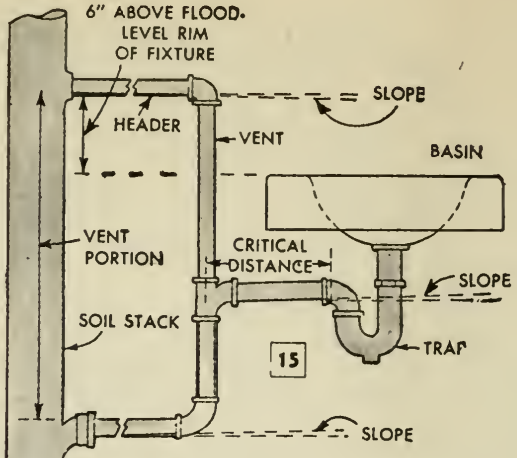
this case may be a 2-in. galvanized-steel stack, screwed to the top of the upper unit and provided with an increaser to prevent frost closure where it extends above the roof. Fig. 13A shows a tapped closet bend and detail B shows a "crowfoot" stack fitting that has two 45-deg. tappings for waste branches; detail also shows an application.

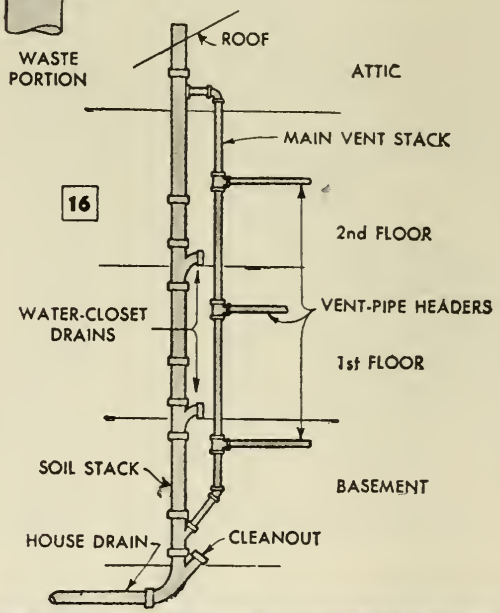
Back vents: When fixtures are too far from the stack for stack venting, as is the case with the arrangement shown in Fig. 10, they are back-vented. This is also required when a water closet, bathtub or shower discharges into the soil stack above them even though they may be close enough to it for stack-venting. The basic idea of venting a fixture is shown in Fig. 15. The vent pipe extends from the top of the drain pipe, vertically or at an angle of not less than 45 deg. from the horizontal. The distance from the vent opening to the crown weir of the fixture trap (see Fig. 22A) is somewhat critical and should not be greater than specified in Fig. 14. It should not be less than two pipe diameters. Also, vent opening should not be below the weir.

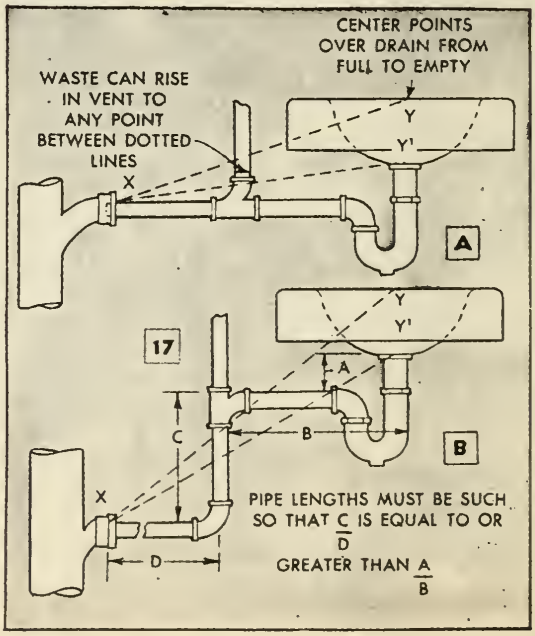
When a long-sweep outlet of a fitting serves as a vent opening, Fig. 17 A, point it in the direction of the fixture discharge. The vent pipe may connect either to the vent portion of the soil stack or to a separate stack by means of a horizontal pipe called a header, which should be sloped so that moisture collecting in it from condensation will run toward the stack or the drainage pipe. The connection of a header to a waste or soil stack should be made at least 6 in. above the flood-level rim of the highest fixture draining into the stack.

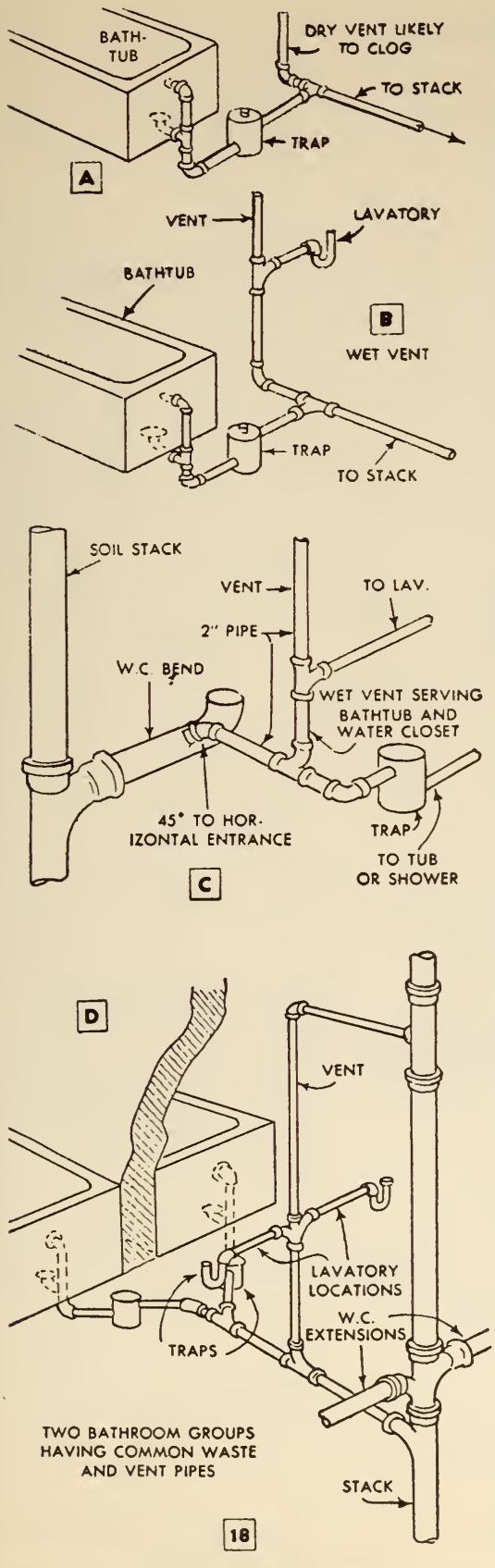
Main vent stack: When fixtures at different heights require venting, it is customary to run headers to a main vent stack, which generally is located close to the soil stack. See Fig. 16. The lower end of the main vent stack may connect to the soil stack or to the house drain; its upper end may terminate above the roof independently, or it may be connected to the vent portion of the soil stack. A vent header should connect to a main vent stack no less than 6 in. above the flood-level rim of highest fixture it serves.

Dry and wet vents: Vents such as shown in Figs. 10 and 15, which are used only to admit air to waste pipes, are called "dry" vents. They should be arranged so that the









TWO BATHROOM GROUPS HAVING COMMON WASTE AND VENT PIPES

18

waste discharge from a fixture cannot rise into the vent opening. This would allow deposits from the discharge to build up and eventually clog the opening. Fig. 17A shows a lavatory vent that is apt to clog because it falls below the lines, XY and XY1, which extend from the center points over the drain when the basin is full and empty, to the point where the waste pipe joins the stack. Waste that is being discharged from a fixture can rise to any point between these lines in a vent pipe connected too close to the trap. Detail B shows a similar lavatory installation in which the pipes are arranged so that the vent opening comes above the lines XY and XY1.

Detail A of Fig. 18 shows a dry vent of a bathtub installation where it is usually impossible to obtain a drop in the pipe as just described. In such cases the customary method of venting consists of connecting the waste pipe of a vented fixture, such as a lavatory, to the bathtub drain—as shown in detail B. Then one vent serves for both fixtures. The lavatory discharge washes away deposits that may collect from the bath discharge. The section of pipe serving for drainage as well as venting is called a "wet" vent. A slightly different arrangement is shown in detail C. Detail D shows an installation of two bathrooms, side by side, where both tubs are wet-vented by the common vent for both lavatories.

The drain from a back-vented kitchen sink or other fixture may be similarly used as a wet vent for a bathtub or shower. In all of these cases, a 1½-in. wet vent should not serve as a waste line for more than one fixture unit and a 2-in. wet vent for not more than four fixture units. Also, the horizontal waste branch should connect to the stack at the same level as the water-closet drain, or just below it, when installed on the top floor. It may also connect to the water-closet bend. On lower floors, the same arrangement requires a 2-in. pipe for the wet vent and its waste extension to the stack. Also, each water closet below the top floor then should be individually back-vented unless the 2-in. wet vent connects directly to the water-closet bend at a 45-deg. angle to the horizontal portion of the bend and in the direction of flow as shown in detail C of Fig. 18.

Diameters and lengths of vent pipes: Pipe used for venting should never be less than 1¼ in. in size nor less than one half the diameter of the drain pipe it vents. A vent stack or the venting portion of a soil stack should not be less than one half the diameter of the soil stack. Generally the vent portion of a soil stack is the same size as its drainage portion, but in many small one-story houses the vent portion may be of reduced size if permitted by local code.

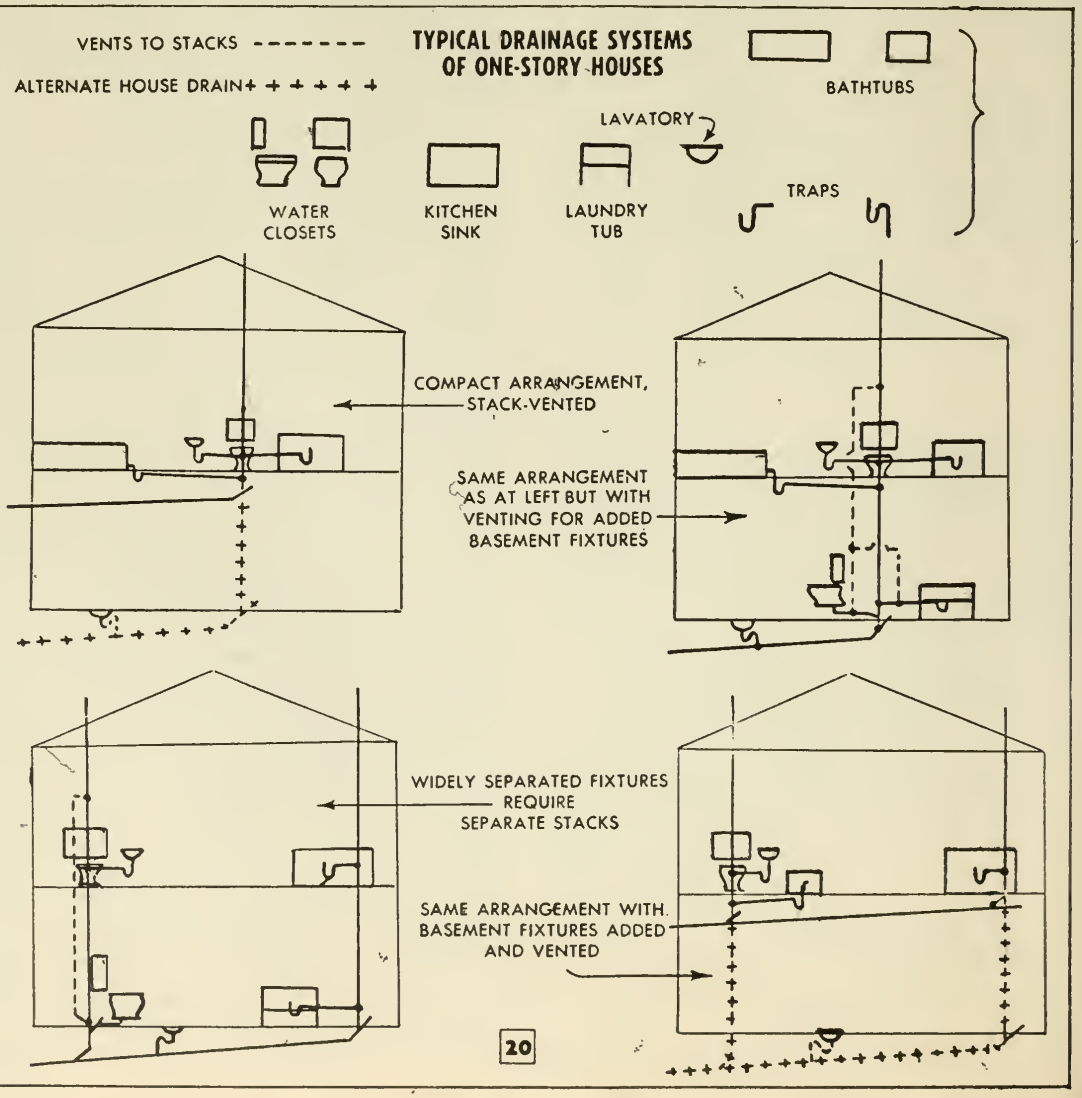
SIZE AND LENGTH OF VENTS

19

Size of Soil or Waste Stock (In.)	Fixture Units Connected	Diameter of Vent Required (In.)						
		1¼	1½	2	2½	3	4	5
		Maximum Length of Vent (Ft.)						
1¼	2	30						
1½	8	50	150					
1½	10	30	100					
2	12	30	75	200				
2	20	26	50	150				
2½	42		30	100	300			
3	10		30	100	200	600		
3	30			60	200	500		
3	60			50	80	400		
4	100			35	100	260	1000	
4	200			30	90	250	900	
4	500			20	70	180	700	
5	200				35	80	350	1000
5	500				30	70	300	900
5	1100				20	50	200	700
6	350				25	50	200	400
6	620				15	30	125	300
6	960					24	100	250
6	1900					20	70	200

U. S. Dept. of Commerce data

TYPICAL DRAINAGE SYSTEMS OF ONE-STORY HOUSES



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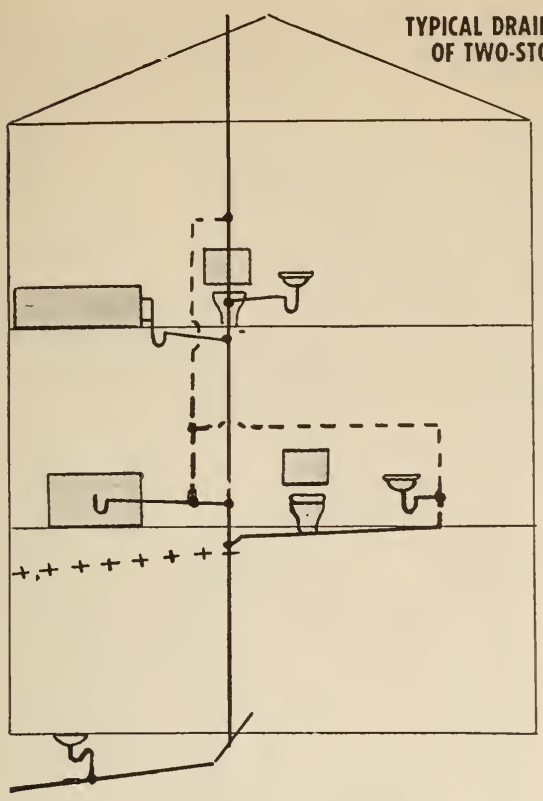
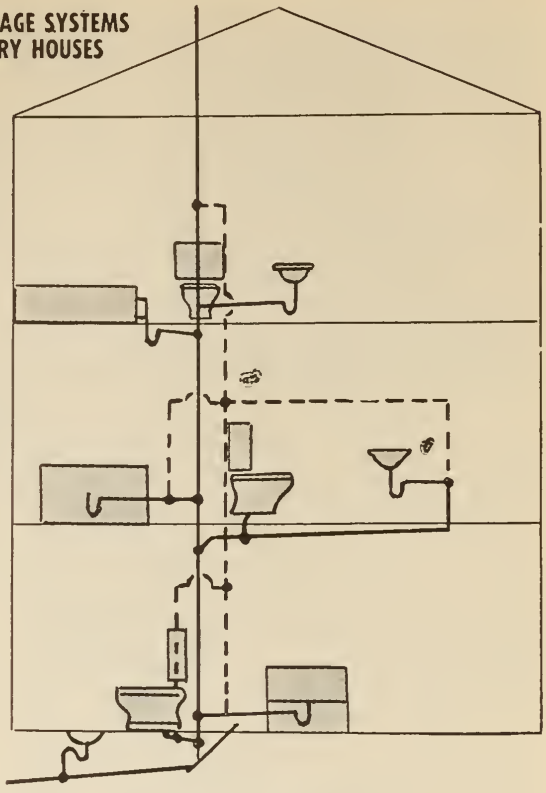
TYPICAL DRAINAGE SYSTEMS OF TWO-STORY HOUSES

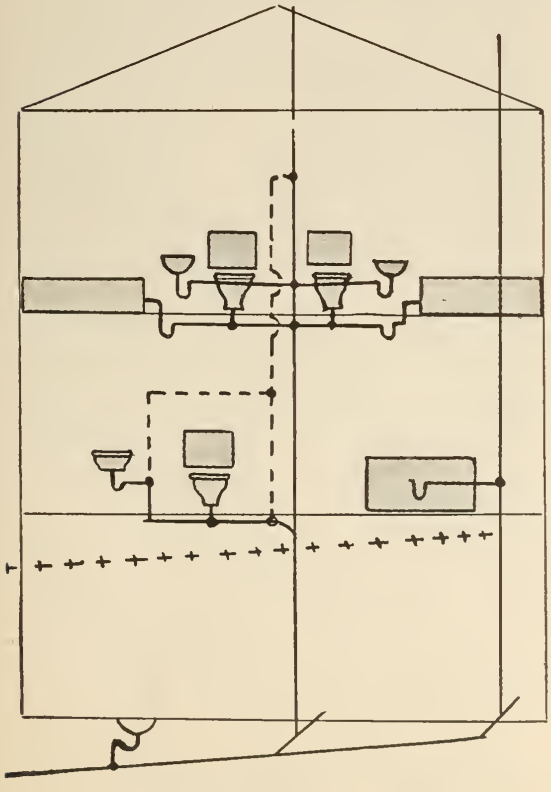


TOP FIXTURES STACK-VENTED
LOWER FIXTURES BACK-VENTED

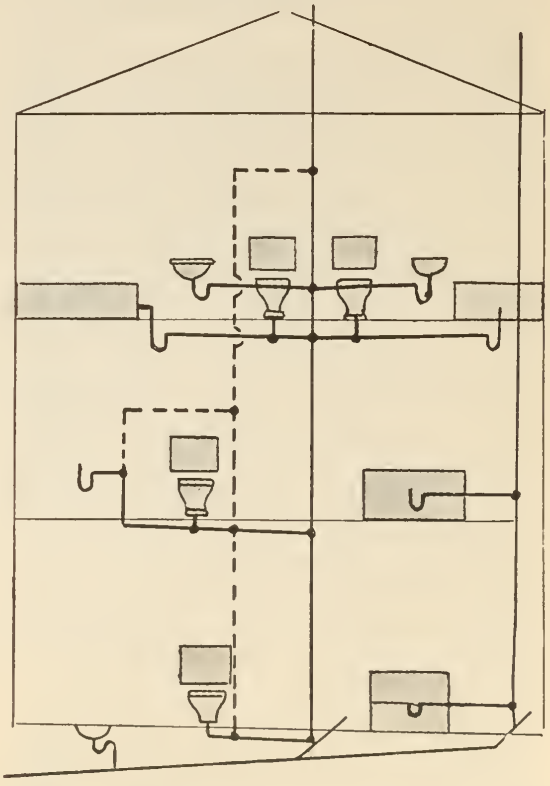


SAME ARRANGEMENT WITH
BASEMENT FIXTURES ADDED
AND VENTED

21



TWIN BATHROOMS ON 2nd FLOOR
TWO STACKS AND VENTING FOR
1st FLOOR FIXTURES



SAME ARRANGEMENT WITH BASEMENT
FIXTURES ADDED AND VENTED

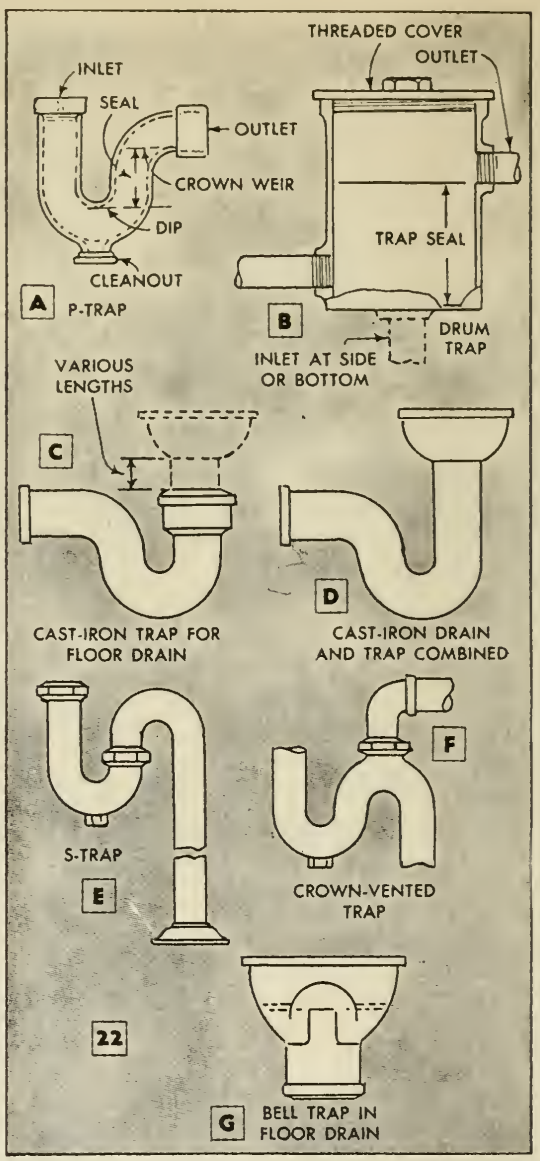
The diameter of vent piping, as well as its length, depends on the number and type of fixtures served and their fixture-unit rating. After determining the fixture-unit load, refer to Fig. 19. Locate the fixture-unit value, or the next higher value, in the second column from the left and opposite the size of the soil stack. Then get the maximum pipe lengths and diameters from the right-hand columns. For example, to find the proper size and length of vent pipe to serve the installation of bathroom fixtures, as shown in Fig. 10, totaling five fixture units, and assuming the soil stack is 3 in., you find that 30 ft. of 1½-in. pipe will serve for 10 fixture units.

As a guide to recommended arrangements of drain and vent pipes, typical drainage systems of one and two-story houses are shown in Figs. 20 and 21.

Where traps are needed: Traps are extremely important parts of a plumbing system as they prevent the entrance of sewer gas into the building without materially retarding the drainage flow through them. A trap forms a dip in the line, which retains enough water discharged through it to provide a seal. The depth of the seal, as measured from the top of the dip to the crown weir or overflow, Fig. 22A, should not be less than 2 in., nor more than 4 in. Traps having a maximum seal are known as deep-seal traps and should be used where the seal is not replenished frequently and may be lost by evaporation: for example, some floor drains.

Each plumbing fixture should be provided with a trap located as close to its discharge outlet as possible. The vertical distance from the crown weir to the outlet should not be over 24 in. One trap may serve a combination fixture such as a sink and laundry tub, if one compartment is not more than 6 in. deeper than the other and the waste outlets are not more than 30 in. apart. One trap also may serve three single-compartment laundry tubs, sinks or lavatories adjacent to each other and not more than 30 in. apart, if the trap is centrally located. For correct sizes of traps to use on various fixtures, refer to Fig. 4, table A. No fixture should be double-trapped, requiring the waste to pass through two traps in succession before it reaches the soil or waste stack, or the house drain. This does not apply to the insertion of a grease trap in the waste line from a kitchen sink if the pipe between the two traps is vented, nor to an arrangement of emptying wastes into a drain or sink. See detail C of Fig. 23.

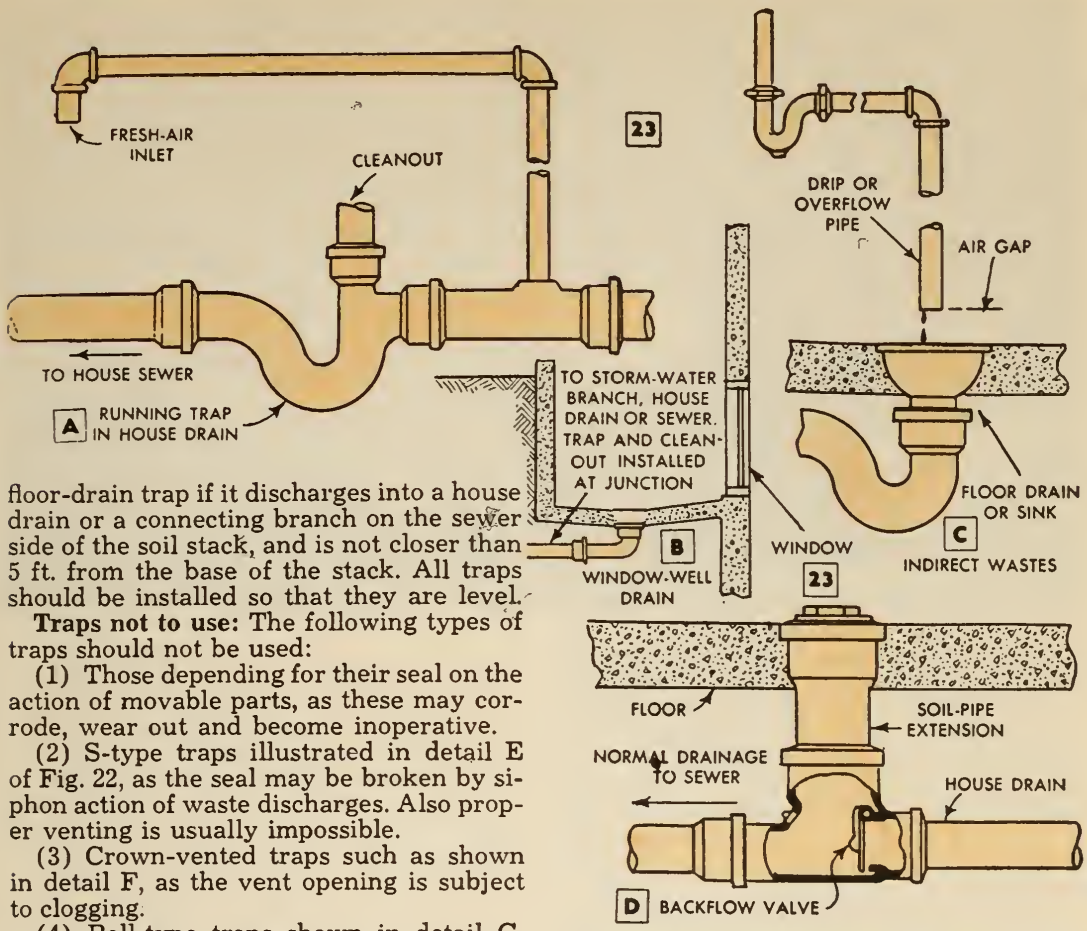
Types of traps: The kind of traps mostly used for sinks and lavatories are the gooseneck or P-type traps, such as the one shown in detail A of Fig. 22. The cast-iron variety



is installed on laundry tubs and basement sinks; the plated brass-tube kind is used where better appearance is desired. Some traps have cleanout plugs, others must be disconnected in case they become clogged. Those made of tubing have a slip joint at one end to fit on the discharge pipe of the fixture, and a union at the other end. Both joints are provided with washers.

Drum-type traps, detail B, are capable of discharging greater quantities of water, and are used mostly for bathtubs and shower stalls. They are set in the floor so that the cleanout cover is accessible, either from above or below. Traps of water closets are cast integrally with the bowl portion.

Detail C shows a cast-iron P-trap used for floor drains. Sometimes a drain and trap are combined in a single casting as shown in detail D. No venting is required for a



floor-drain trap if it discharges into a house drain or a connecting branch on the sewer side of the soil stack, and is not closer than 5 ft. from the base of the stack. All traps should be installed so that they are level.

Traps not to use: The following types of traps should not be used:

(1) Those depending for their seal on the action of movable parts, as these may corrode, wear out and become inoperative.

(2) S-type traps illustrated in detail E of Fig. 22, as the seal may be broken by siphon action of waste discharges. Also proper venting is usually impossible.

(3) Crown-vented traps such as shown in detail F, as the vent opening is subject to clogging.

(4) Bell-type traps shown in detail G, which are often used for floor drains; the seal depends on a partition which in time may be corroded or broken, thus destroying the ability of the trap to retain a seal.

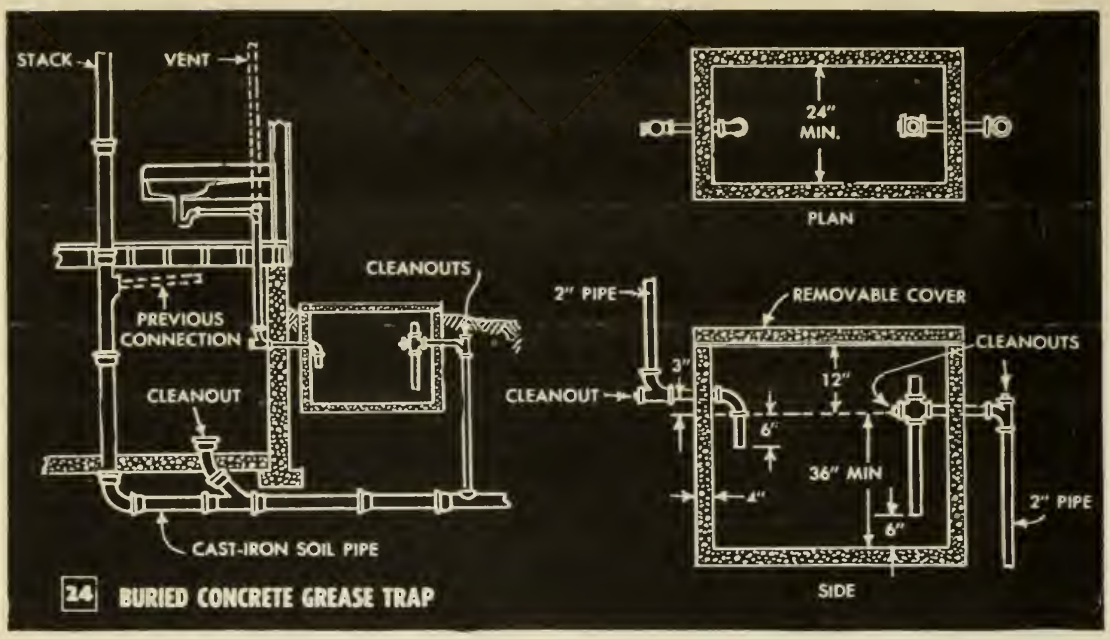
House traps: Where required by local code, a "running" house trap is installed in the house drain near its outlet, as shown in Fig. 23A. Its function is to prevent sewer gases from getting into the plumbing system of the building, but it is objectionable from the standpoint that the trap reduces the discharge capacity of the drain and also causes back pressure. The fresh-air inlet or relief vent of a house trap need not be larger than half the size of the drain pipe to which it connects.

Storm-drain traps: Storm-water drains connected to combination house drains and sewers are trapped either by an individual trap in each branch or by a single trap in the main drain before it connects to the combination sewer. No traps are required for drains emptying into sewers used for storm water exclusively. Any underground trap, except a P-trap of a floor drain, should be provided with an accessible cleanout, and should be protected from frost.

Window-well and areaway drains: Often deep window wells or other areas such as basement entrances are provided with drains, Fig. 23B. This is particularly true in locations where they are apt to fill up with snow. Since water in a trap at the drain would be subject to freezing, a trap and cleanout are provided underground in the line just before it connects to a storm-water branch, house drain or house sewer.

Refrigerator and other indirect wastes: Waste water dripping from an ice-cooled refrigerator, or the overflow of a water tank, can be discharged into a sink or floor drain as shown in Fig. 23C. An advantage of this arrangement is that it maintains a constant seal in the trap because of the continuous or occasional discharge. An air gap should be provided between the trap and the drip pipe. In case of a refrigerator, or any other device containing food, the drainpipe should be provided with a separate trap to prevent the passage of air and insects to the interior. In no case should the drainpipe of any food-containing device be connected directly to a drainage system.

Backflow valve in house drain: Where sewers are overtaxed and backflow into house-drainage systems is likely to occur, particularly in case of combination sewers after a heavy rainfall, it is advisable to in-

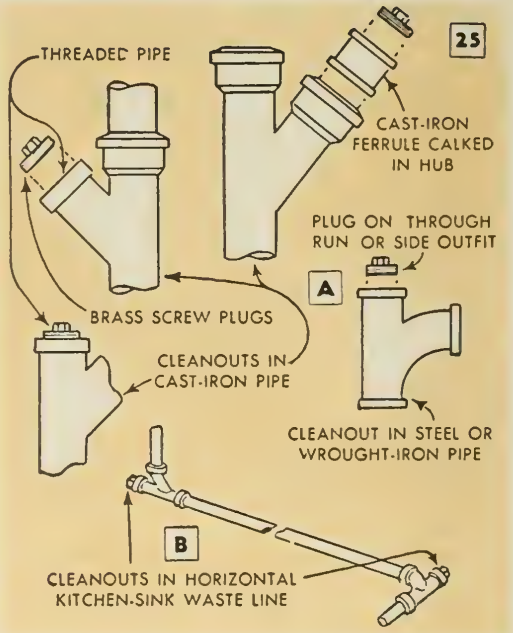


24 BURIED CONCRETE GREASE TRAP

stall a backflow valve in the house drain. The best location is just within the building near the outlet of the drain. If located within arm's reach under the basement floor, access is possible by simply extending the top opening with a length of soil pipe as shown in Fig. 23D. The hub is closed by means of a ferrule and brass screw plug. Where the distance from floor to backflow valve is more than 12 or 15 in., it is best to provide a concrete pit of convenient size.

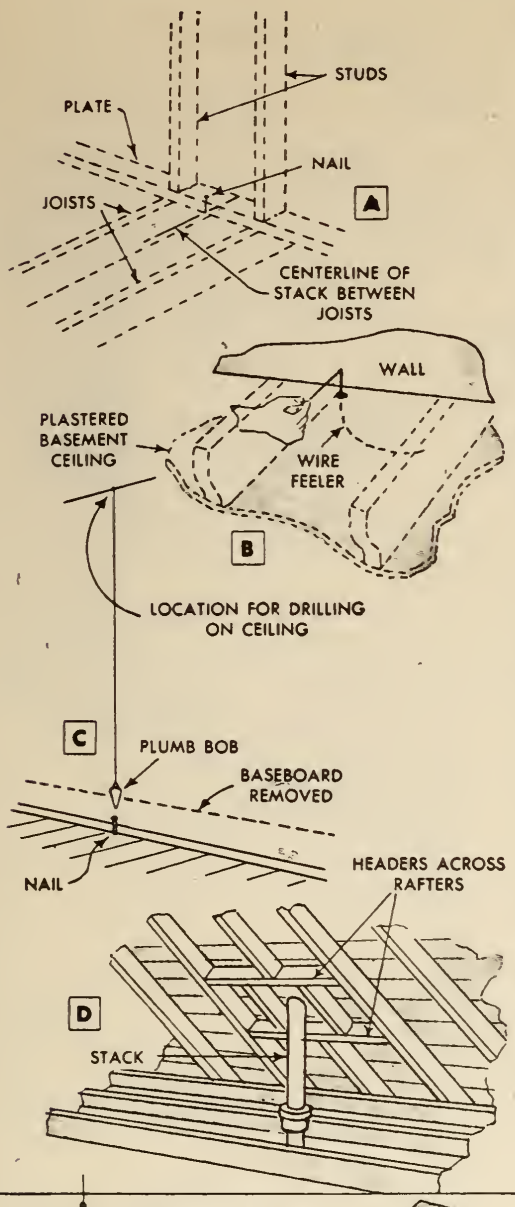
Grease trap or catch basin: Some communities require a catch basin or grease trap. A grease trap should be used in an individual disposal system when grease drained into the kitchen sink is more than average. However, a grease trap should not be connected in the same waste line with a garbage-disposal unit. Grease traps may be of the small undersink variety, which require frequent cleaning, or the large kind buried outside of the house but as close as possible to the sink as in Fig. 24, which also gives recommended dimensions. The trap extends to ground level and a suitable cover is provided. As a rule grease traps are generally not required for small homes. Their use has been discontinued in many communities mostly because of the usual neglect in cleaning them.

Pipe cleanouts: Cleanout plugs are shown in Fig. 25A. One should be installed at the base of each soil or waste stack. One should also be installed near the junction of the house drain and house sewer, and at each change of direction of the house drain that is greater than 45 deg. Cleanouts are quite necessary at the upstream end of long horizontal waste lines, Fig. 25B, especially those from kitchen sinks, where congealed



grease in the pipe may cause clogging. In homes built on cement slabs or over crawl spaces less than 18 in. high, the stack-base cleanout can be projected just outside of the building wall downstream from the stack. When a cleanout is used in an underground drain, it should be made accessible by extending it to or above grade level, and directly over its location. Similarly, cleanouts for concealed piping in walls and floors should be accessible.

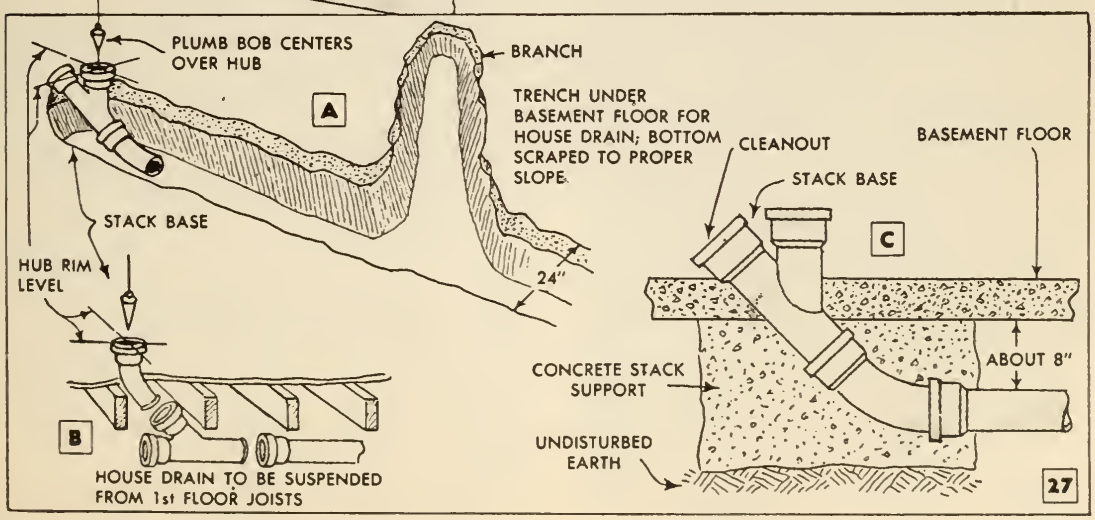
Installing drainage system in existing house: Installation of a drainage system starts with placing the stack base or foot piece; then laying the house drain and set-



ting up the stack. First make a few preliminary checks to see if the stack and fixtures can be installed as planned. Also recheck the location of the waste and vent pipes through partitions and floors to the points where they connect to the soil stack. If the stack is to run inside a wide partition, remove the baseboard at the first-floor level, and drive a 10d finishing nail through the floor next to the partition to indicate the stack centerline. Fig. 26A. Then check the nail position from the basement to see whether stack will come between joists. If necessary alter the stack centerline for clearance. If the basement ceiling is plastered, get a ¼ by 18-in. electrician's bit and ratchet brace, and drill through the floor next to the plate. A bent wire should be used to feel where the joists are located, as in detail B.

Next, suspend a plumb bob from the ceiling of the first floor directly above the nail or hole, in detail C, and mark the ceiling. Then tap on a block held against the ceiling to check the position of joists. If the distance from mark to joist is insufficient for stack clearance, make the necessary adjustment both at this point and also below. If this is impossible, plan to use a header so the joist can be cut to provide clearance. When the center of stack location through the ceiling is decided, drill a hole through the ceiling and floor above it as a basis for further lineup to the second-floor ceiling. If the stack position comes directly under a rafter, plan either to install headers as in detail D or to offset the stack.

Laying the house drain: Drop a plumb line from the center of the stack position at the basement ceiling to mark the basement floor. Next, mark a line on the floor from this point toward the point where the house drain is to connect to the house sewer. Similarly mark locations of the branch drains.

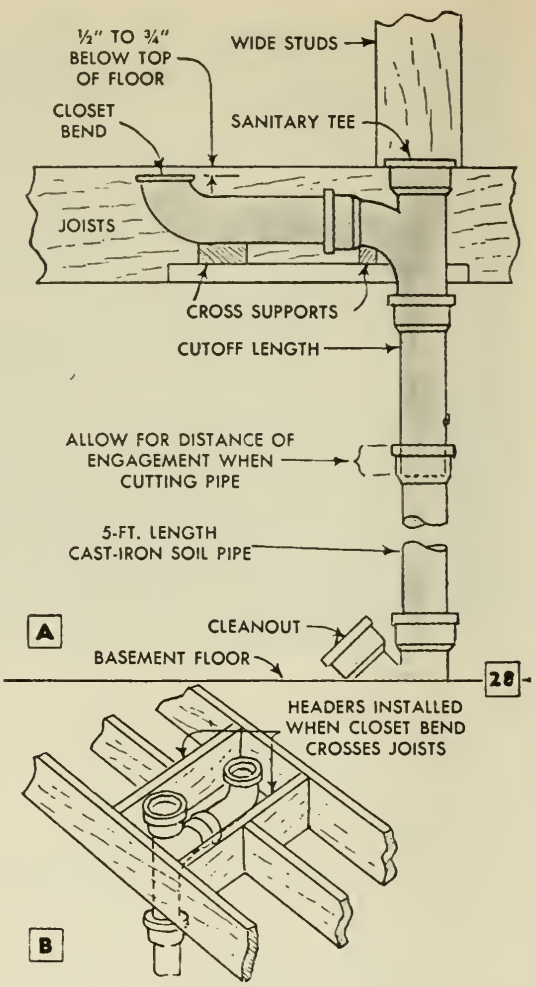


Break up a strip of floor about 24 in. wide, centering at the marked lines, and dig trenches as in Fig. 27A. The 24-in. width gives just enough space to calk the pipe joints. Start digging at the stack location, just deep enough for cast-iron soil pipe to rest about 8 in. below the floor. Continue the trench toward the outlet, increasing its depth as necessary to obtain the proper slope, which can be ascertained by the method shown in Fig. 33A.

The stack base may consist of a 45-deg. Y-fitting and a ⅛ bend fitted together and calked, or it may be a specially made stack base. Both are shown in Fig. 12. If the house drain is to be suspended from the basement ceiling, the fittings are arranged as shown in Fig. 27B, and the line is supported with hangers spaced not over 5 ft. apart. In either case, the stack base is adjusted so that the hub to which the stack is to connect is perfectly level across its rim and also centers around the suspended plumb bob. Tamp earth firmly around the pipe to hold it in position temporarily. Then continue to install sections of pipe in the trench. The hubs always point upstream. The proper fittings are installed at the right points to connect branch lines, using long-sweep fittings with the branch inlets pointing downstream. No double-hub nor double-T fitting should be used in horizontal soil or waste lines. To locate the fittings correctly, you may have to cut lengths of pipe. The hub and spigot ends of adjoining pipes must be concentric so that the annular space for calking is of uniform width. The trench bottom should support the entire barrel portions of the pipe; therefore slight concavities are dug under the hubs as shown in Fig. 33B.

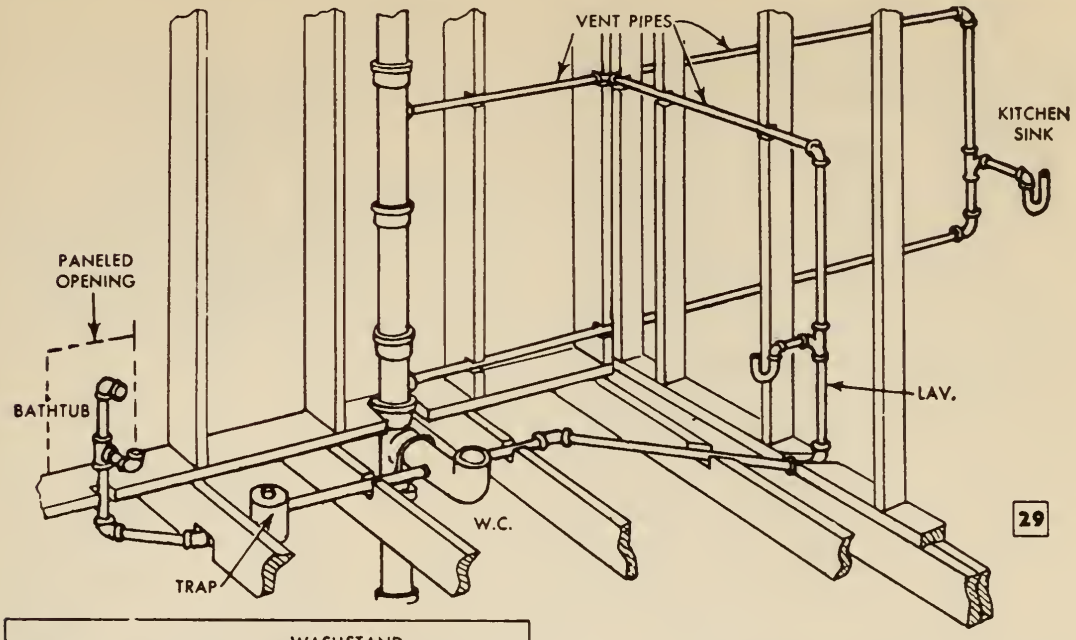
The trench is not filled with earth until the drainage system has been tested for leaks. This will be explained in detail later. When laying a house drain it is sometimes more convenient to start laying the pipe from the outlet toward the stack. When this procedure is followed the stack-base assembly must be shifted about 2½ in. so that the last joint can be made, after which it is forced back to its original position, adjusting the hub to get it level. When the house drain has been completed, dig a space under the stack base about 18 to 24 in. square and about 10 in. deep. Fill this with concrete as shown in Fig. 27C for good stack support.

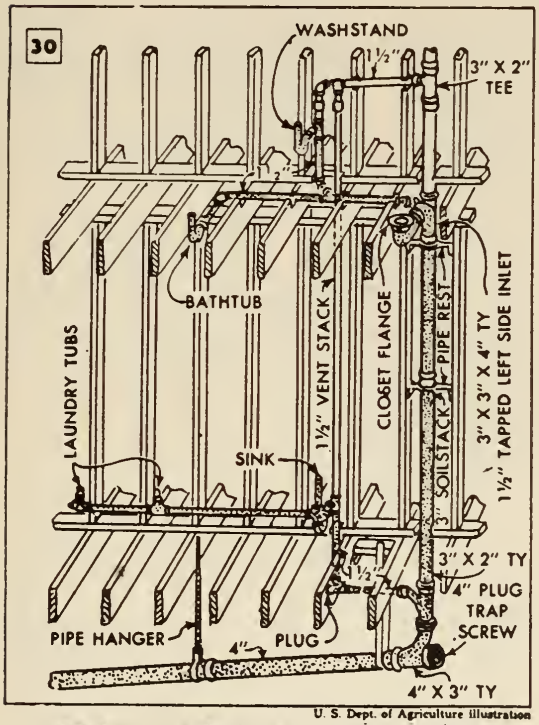
Setting up the stack: After the concrete has set for a day or so you can begin to assemble the stack. If a waste connection from the laundry tub goes to the stack, install a T-fitting and calk the joint, making sure that it is plumb. Where basement waste pipes are not so connected you install a full 5-ft. length of soil pipe. Then cut holes in the first floor, one through the partition sill or next to it, depending on the exact stack location. Another hole should be cut for the outlet of the water-closet bend, if a water closet is planned for the first floor. It usually is necessary to open the floor to install pipes, although an open basement ceiling often permits installing pipes from below.



The second pipe length must be cut short so that the sanitary T-fitting for the water-closet connection will be at the right height as shown in Fig. 28A. The closet bend or pipe extension to it is arranged at the proper slope so that the outlet of the bend comes ½ to ¾ in. below the top of the floor. If the bend is too long it can be cut. One or more supporting crosspieces on cleats nailed to joists are used to support horizontal soil pipe between joists. Where a closet bend or extension crosses joists, headers are provided as shown in Fig. 28B. The stack also must be supported at least every 8 ft., as described on p. 1729. It will be necessary to remove a strip of plaster from floor to ceiling, Fig. 32A, when soil pipe is set in a partition. You may have to "box out" the wall to accommodate the pipe.

After the stack has been completed to





SUPPORTING AND ROUGHING-IN A SIMPLE SYSTEM HAVING CONTINUOUS WASTES AND VENTS. DRAINAGE PIPES ARE STIPPLED AND VENT PIPES ARE OUTLINED

the first-floor level, check the exact location of connections to waste pipes, select fittings accordingly and cut the pipe where necessary. In case no water closet is planned for the lower floor, a connection may be required for the waste line from the kitchen sink, although this may also be brought to the stack underneath the floor. Continue building up the stack to the water-closet extension on the second floor. Above this point the fittings for waste and vent connections are incorporated, and the stack is continued so that it will extend no less than 6 in. above the roof, shingles having been removed and the roof boards already cut. Stack flashing is installed when the shingles are replaced. Openings in floors and partitions where pipes are installed should be ratproofed with sheet metal.

Concealed waste and vent pipes: Concealed work in new-house construction is comparatively simple but in existing homes some flooring must be taken up and plaster removed. To cross joists and studs, notches are cut in them, as shown in Figs. 29 and 30. Where joists or studs are weakened by notching, they should be reinforced. To connect drainage and water-supply pipes to a built-in tub, accessibility is provided by opening the wall, framing the opening and then providing a door or panel, as in Fig. 31. A bathtub trap must be accessible. Drum traps are the most adaptable for underfloor work, being arranged so that the cover is flush with the floor or is accessible from below.

Opening walls and floors: Fig. 32A shows how a minimum amount of wall covering is removed to install waste and vent pipes. After marking off the exact location of the pipes on the walls, cut through plaster and plaster base as required. Vertical cuts through plaster are made alongside studs, and cleats are nailed to the studs for fastening the wire lath, as shown in detail B. In small bathrooms flooring may have to be removed entirely from wall to wall to uncover an area large enough to install the pipes. If cutting a floor is necessary, use a

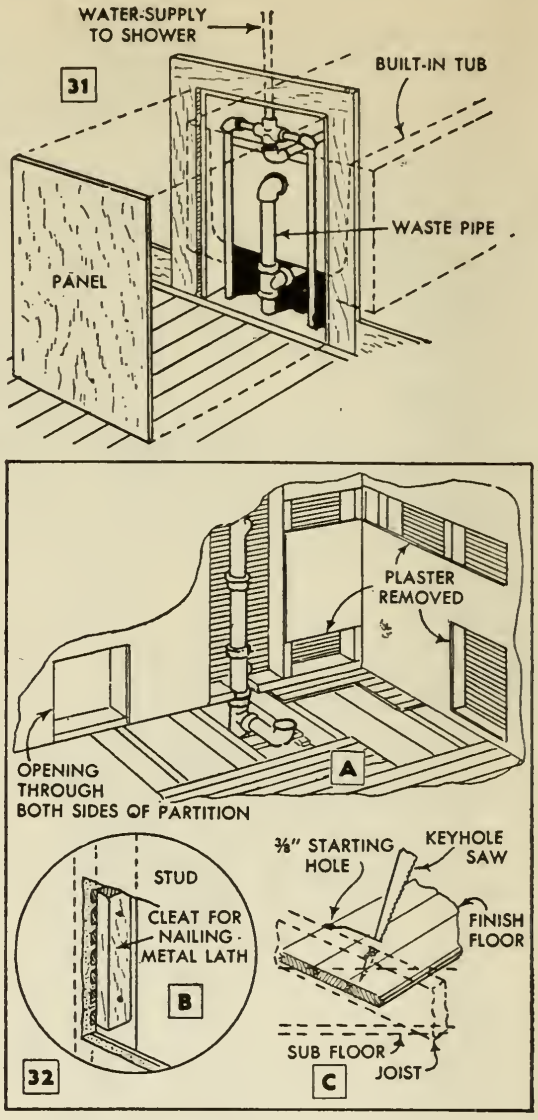
keyhole saw, starting to cut from a small hole and sawing alongside the joists. See detail C. This permits nailing a cleat to the joists as a base to which the cut floor boards are later nailed.

Installing house sewer: Although the house sewer may be installed before the house-drainage system, it is often done afterwards. Its size should not be less than that of the house drain, and it may have to be larger, as for instance when storm water is emptied into it. It is important that the joints be made watertight and rootproof. The line should be as straight as possible and should be below the frost depth. The usual slope is ¼ in. per ft., and the method of determining the slope is shown in Fig. 33A. Various kinds of pipe are used for house sewers as described in the section on pipe. An acid-resisting type of pipe is needed when the soil contains cinders and ashes as metal pipe then is subject to excessive corrosion. When some types of pipe other than cast-iron pipe are laid in filled or unstable soil, they should be placed on concrete pads for uniform support.

Digging trenches: Digging a trench in clay or other compact earth usually is safe, but in unstable soil, particularly sand, it is necessary to prevent the sides from caving in. "Shoring" for sides to prevent cave-ins consists of planks—or forms rented from a concrete contractor—which are suitably braced as shown in Fig. 33C. The pipe should be placed on compact, undisturbed earth. Rocks at the trench bottom should be removed. If the bottom is very rocky excavate 4 in. below grade and backfill with fine gravel or coarse sand to assure uniform support of the pipe.

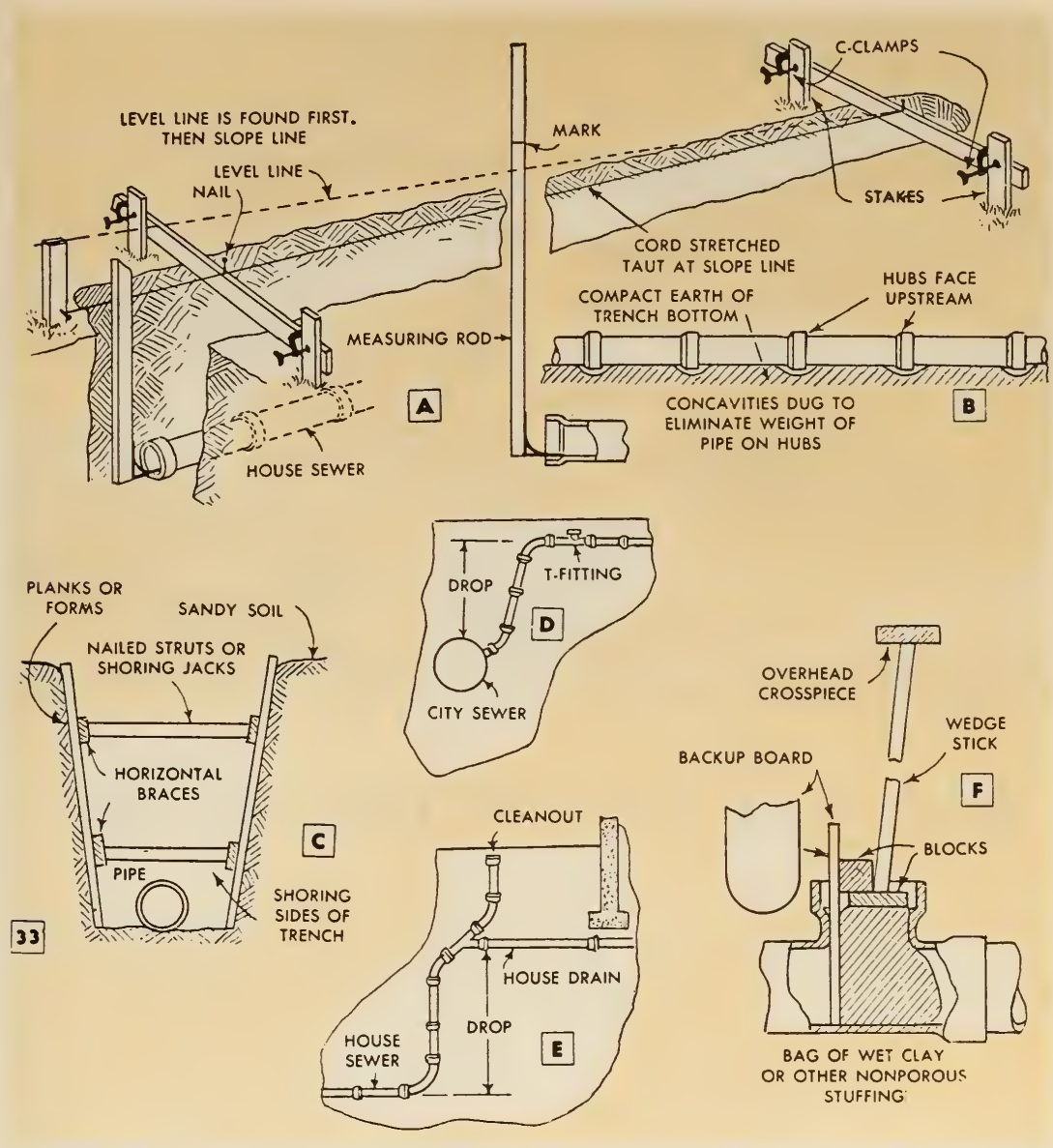
In case the drop from the house-drain outlet to the city sewer or individual septic tank is much greater than can be negotiated with pipe slope, an additional drop may be required. This can be provided by a short steep slope near the city sewer as in Fig. 33D. The drop can be located also at the house-end of the line as in detail E. A drop that slopes more than 45 deg. from the horizontal should be provided with a cleanout opening. In no case should a drop be located within 15 ft. from the entrance to a septic tank, since the accelerated velocity of the drainage flow would interfere with the proper action of the tank. A T-fitting inserted at the outlet end of the house sewer, detail D, provides a means of sealing this end of the line when making a leak test on the drainage system after it is completed.

Connection to city sewer: Connection to the city sewer usually is done by or under supervision of municipal employees. Vitrified-clay sewers generally are provided with 6-in. Y-fittings at each lot location for attachment of house sewers, requiring only



the removal of the plug and the insertion of a curved section of pipe. Concrete sewers generally must be tapped and a pipe stub cemented in the hole. The trench in which the house sewer is laid is not filled until after testing has been accomplished. When filling a trench containing a pipe that can be damaged, such as vitrified-clay pipe, avoid throwing large stones and rocks in with the fill until the pipe has been covered for a depth of at least a foot or so. Thus you avoid unnecessary breakage.

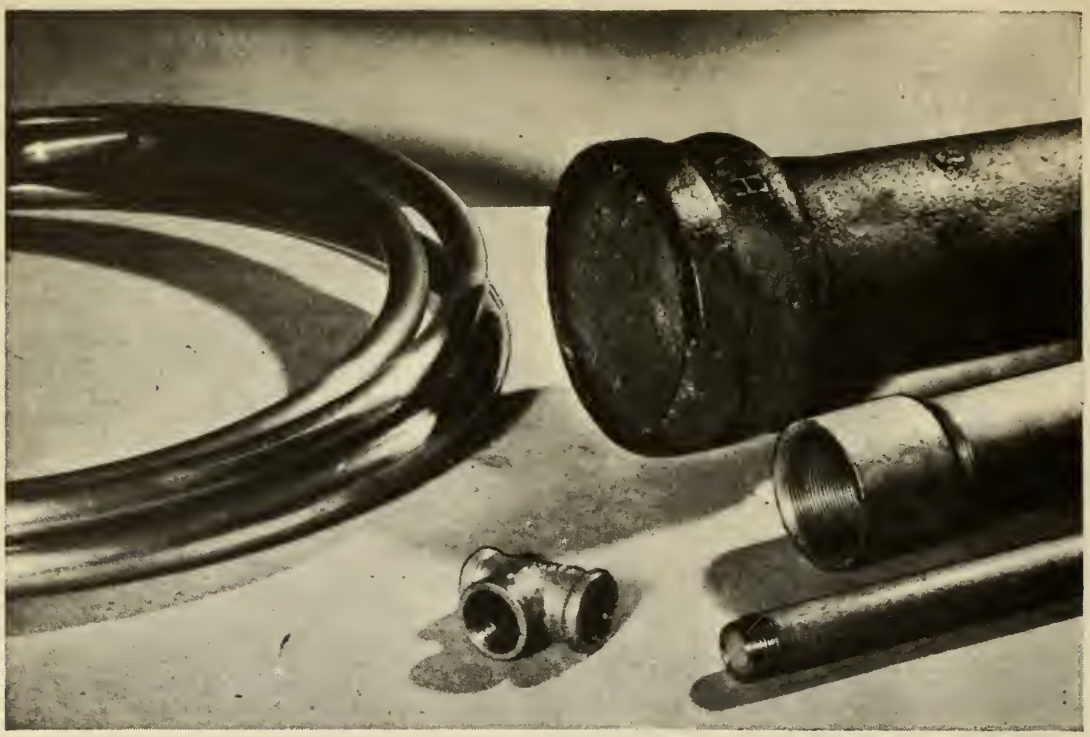
Testing for leaks: After a drainage system has been completed, it should be tested for leaks before the installation is approved. To make the test, close the street end of the house sewer with a test plug or do it by plugging the pipe with a bag of wet clay as in Fig. 33F. Close all other openings below the stack terminal. On waste pipes you simply use pipe caps. Closet-bent and floor-



drain openings can be closed with test plugs or bags of clay.

When all openings are made leakproof, fill the system with water through the stack terminal, using a hose. Then inspect all the joints and pipes for leakage. If leaks are found at joints, the cause usually is defective calking, although a pipe may be defective also. Such joints are recalked or defective pipe replaced after letting out the water by opening the house sewer. The surfaces to be calked should be thoroughly dry. After the final test, the T-fitting in the house sewer is closed by cementing in a disk.

Frost protection and insulation: Besides the need of burying the house sewer at a depth sufficient to prevent freezing, soil and waste pipes installed in outside walls or in unheated spaces under floors often require insulation against freezing. Insulation is applied all around the pipe, especially between them and the outside walls. Cold drafts in partitions and floors may be stopped by headers nailed across the studs or joists. Sometimes warm air admitted through a register from the basement is highly effective in preventing frozen waste pipes. Noise caused by water being discharged through soil and waste pipes is sometimes objectionable. It may be amplified considerably if the pipe is in contact with a wall. Where such effects can be anticipated, the pipes should be wrapped with soundproofing insulation when they are installed.



PIPE FOR ANY PLUMBING JOB

IT MAKES A BIG DIFFERENCE, generally, what kind of pipe and fittings you use for a plumbing job. Some kinds are developed for specific purposes while others have a variety of uses or may be more suitable for some jobs than others, besides varying in cost and durability. Therefore the reference data contained in this section concerning various kinds of pipe and fittings, their purposes, and also how pipe is prepared and installed will be of help in selecting and using pipe.

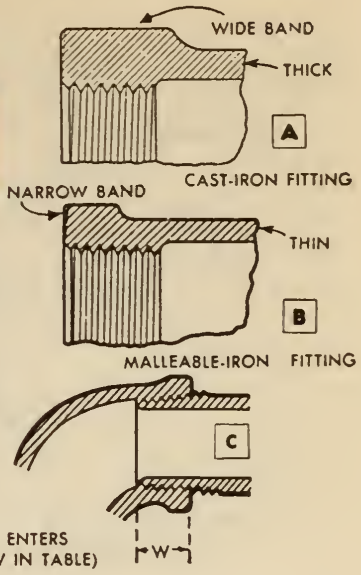
Kinds of pipe for plumbing: Pipe can be classified as to its use in home plumbing systems as follows: (1) Water-supply pipe, which may be galvanized wrought-iron and steel pipe, brass and copper pipe, copper tubing and also plastic pipe; (2) drain and vent pipe, which may be galvanized wrought-iron and steel pipe, cast-iron soil pipe, vitrified clay pipe, cement pipe, lead pipe, copper pipe and tubing, asbestos-cement pipe and bituminized-fiber pipe. Some of these are used for different purposes; others are restricted to certain specific applications and treatment.

Wrought-iron and steel pipe: Used for water distribution, for waste and vent lines, wrought-iron pipe is more resistant to rust than steel pipe but also is more expensive. Either kind is available in black or galvanized finish, but only the latter should be used for permanently installed lines because of the added protection it provides against rust. Life of galvanized steel pipe generally ranges from 15 to 30 years; that of wrought-iron pipe from 20 to 40 years. Identifying wrought-iron and steel pipe from appearance is difficult for the average person, and therefore he must rely for this on the manufacturer's markings put on first-grade pipe of either type. Reference here to steel pipe also includes steel-alloy pipe, such as copper-bearing pipe which contains about 0.2 percent of copper by weight and usually is galvanized.

Standard-weight wrought-iron or steel pipe comes in random lengths up to 22 ft., with both ends threaded and protected with couplings. Sizes range from ⅛ to 12-in. nominal inside diameters. Fig. 1 gives dimensions and other data on wrought-iron and steel pipe up to 2½-in. size. Besides the standard weight there is also an "extra strong" and a "double extra strong" weight. These, having thicker walls than standard-weight pipe, are used for higher pressures than usually found in most home plumbing

DATA ON STANDARD WEIGHT WROUGHT IRON AND STEEL PIPE FROM ⅛" TO 2½"; FURNISHED IN RANDOM LENGTHS UP TO 22 FT.
(All Dimensions in Inches)

Nominal Size	Outside Diameter	Inside Diameter	Wall Thickness	No. of Threads Per In.	Length of Effective Threads	Normal Engagement For Tight Fit (W)
⅛	0.405	0.269	0.068	27	.2639	¼
¼	0.540	0.364	0.088	18	.4018	5/16
⅜	0.675	0.493	0.091	18	.4078	⅜
½	0.840	0.622	0.109	14	.5337	7/16
¾	1.050	0.824	0.113	14	.5457	½
1	1.315	1.049	0.133	11½	.6828	9/16
1¼	1.660	1.380	0.140	11½	.7068	9/16
1½	1.900	1.610	0.145	11½	.7235	9/16
2	2.375	2.067	0.154	11½	.7565	⅝
2½	2.875	2.469	0.203	8	1.1375	⅞



systems. The outside diameters of pipes having different wall thicknesses are the same, but the inside diameters vary. For example, the outside diameter of a 1-in. standard-weight pipe and that of a 1-in. double-extra-strong pipe are both 1.315 in., but the inside diameter of the former is 1.049 in., and that of the latter is only .599 in.

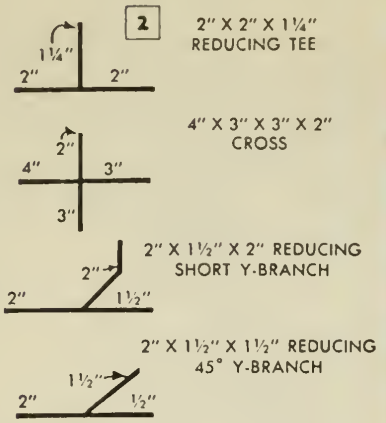
Water-pipe fittings: The only pipe fittings that are made of wrought iron and steel are nipples and couplings. Both are short lengths of pipe, nipples being threaded externally and couplings internally. Other fittings are made of cast iron or malleable iron. Malleable iron is preferable as it is tougher and not so brittle as cast iron. You can distinguish between cast-iron and malleable-iron fittings in that the latter have thinner and narrower bands as shown in Fig. 1A and B. Fittings in water lines should be galvanized to retard rusting.

A number of fittings in common use are shown in Fig. 3. Externally threaded ends are called "male" ends and internally threaded ends are referred to as "female." Nipples come in various lengths—17 lengths from 1⅜ to 12 in. in the ¾-in. size. Couplings connect two pipes end to end where they need not be disconnected later. A reducing coupling joins pipes of different sizes. Unions connect pipes end to end near meters, water heaters and other fixtures that may have to be disconnected; unions also are placed in a line where a branch line may be inserted later. Flange-type unions generally are used on pipes over 2 in. in size.

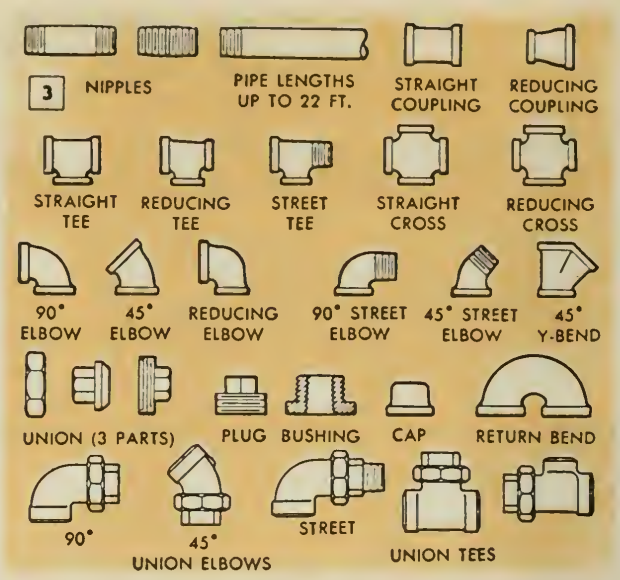
Regular and reducing elbows join pipe at 45 and 90 deg.; street elbows (45 and 90 deg.) differ in that they have one tapped and one threaded end, the latter end to join another pipe fitting or a matching tapped hole. Regular or reducing tees join three pipes at 90 deg.; a street tee has one outlet threaded like a street elbow. A Y-branch connects two pipes end to end, and a third pipe at a 45 deg. angle. There are also regular and reducing crosses.

Plugs are used to close one end of a fitting; caps to close the end of pipe. Bushings have a hexagon bearing surface to take a wrench; they are threaded internally and externally to make a connection from a pipe or fitting of one size to one of another size, where a reducing coupling cannot be used. Return bends connect the ends of two or more pipes running parallel to each other, as in a bank of pipes used for heating. Return bends are furnished in close, medium and open types for different spacing of pipes. On ¾-in. pipe, return bends have 1½, 1⅞ and 2½-in. center-to-center spacing respectively. Hose fittings have different threads and will not fit standard threaded pipe and fittings, except sill cocks and laundry faucets, which are threaded to permit hose connections.

Fittings for threaded drainage pipes: Fittings for threaded drainage pipes differ radically in design from ordinary pipe fittings. Those of larger sizes are usually cast iron. One essential difference between regular and drainage fittings is shown in Fig. 4. The internal diameter of the body section of a drainage fitting is the same as that of the pipe it fits. The tapped section of the fitting is recessed so that the end of the pipe butts against the shoulder, thus preventing a "ledge" against which waste can collect and start an obstruction. The second essential difference between regular and drainage fittings is that the latter have slightly slanted or pitched outlets (¼ in. per ft.) for connection to horizontal drainage and vent pipes that must be pitched. In Fig. 5, which shows a number of common drainage fittings. Pitch is indicated by the dotted lines. In drainage lines, fittings of long radii or a combination of fittings for gradual change of direction should be used



HOW TO SPECIFY SIZES OF REDUCING FITTINGS

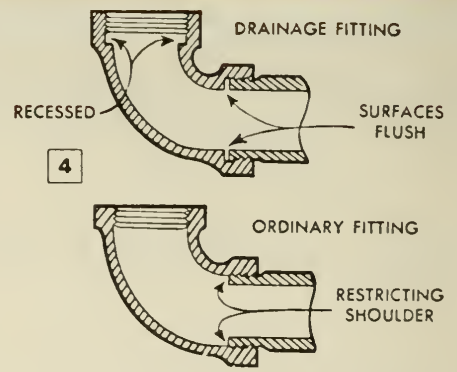


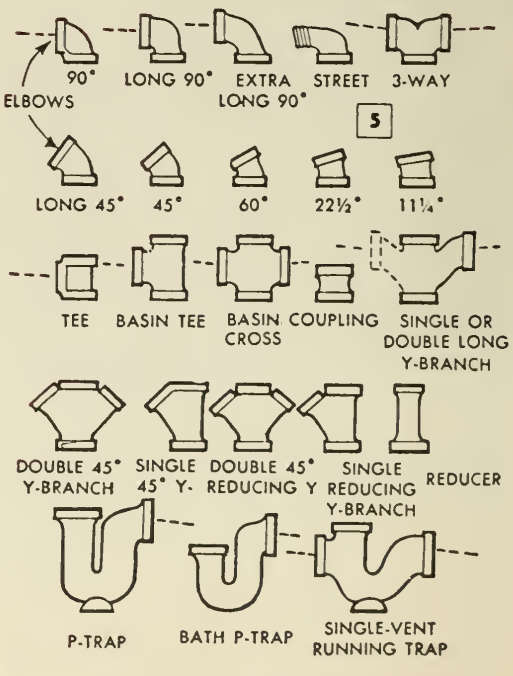
wherever possible as a preventive measure against stoppage.

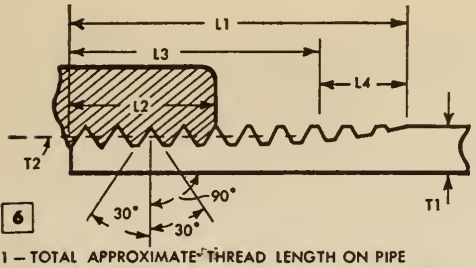
Ordering pipe fittings: All fittings are referred to by the pipe size on which they are used, which precedes the name of the fitting. For example, a ¾-in. elbow has both outlets for ¾-in. pipe. In giving the sizes of reducing tees and Y-branches, the larger run is given first, then the smaller run followed by the inlet or branch, as indicated in Fig. 2. Reducing crosses should be specified similarly except that both outlets are given, the smaller one last. For crosses having both run openings of the same size and both outlets of one size, only the run and outlet sizes need be given. For bushings the external size comes first, then the internal size.

Brass and copper pipe: While the initial cost of brass and copper pipe is more than that of wrought-iron and steel pipe, it will last the life of a building. It is required in some localities where water is extremely corrosive. Besides the economy gained by avoiding replacement of steel pipe, of which a large percentage is labor cost, it is possible to use smaller sizes of brass and copper pipes, which means a saving. Smaller sizes can be used since brass and copper pipe has a smooth inside surface which causes less resistance to the flow of water than iron and steel pipe of similar size.

Brass and copper pipe is furnished in the same sizes and in practically the same wall thicknesses as iron and steel pipe, but in 12-ft. lengths. Threads are also the same size except for the fine thread used on thin-wall drainage fittings. When cutting and threading brass and copper pipe, a lubricant or cooling medium such as lard oil or soapy water reduces effort and helps to produce clean, sharp threads. Wrenches of







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L1 — TOTAL APPROXIMATE THREAD LENGTH ON PIPE
L2 — NORMAL ENGAGEMENT OF FITTING BY HAND
L3 — EFFECTIVE THREADS THAT SHOULD BE SCREWED INTO FITTING
L4 — THREE TO FOUR IMPERFECT THREADS DUE TO DIE
T1 — FULL WALL THICKNESS OF PIPE
T2 — TAPER OF ¾ IN. PER FT. ON DIAMETER

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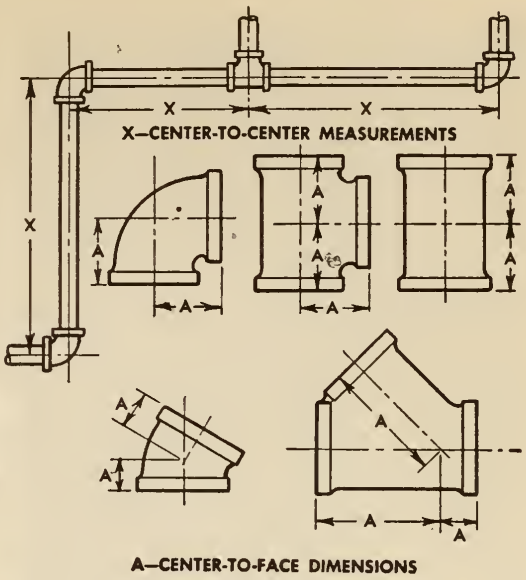
the friction or strap type should be used to avoid marring brass and copper wire. Also, the vises should be fitted with friction clamps instead of toothed jaws.

For brass pipe, the fittings used are the same type as those for iron and steel pipe. Special alloy fittings for either brass or copper pipe are used. Iron or steel fittings should not be used on brass and copper pipe as they will rust faster because of electrolytic action between dissimilar metals. Chrome-plated brass pipe generally is used for exposed portions of water-supply and



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drainage lines that run from floors or walls to fixtures.

Standard pipe threads: To assure strong, well-fitting joints that are watertight, threads on pipe must be of correct length and depth and must be clean and sharp. Pipe threads have a taper of ¾ in. per foot. Fig. 6 shows the number of threads required on pipe for a good fit. Such correct thread length results when the die is brought flush with the end of the pipe or when the pipe projects only half a turn beyond the die. Table, Fig. 1, gives the correct distance that the threaded end of pipe should enter fittings as indicated in detail C.

How to measure pipe runs: When installing pipe, first take the actual center-to-center measurements of the pipe run, as indicated by letter X in Fig. 7. The lengths of pipe between the various fittings must be shorter than the X-dimensions to allow space for the fittings, yet must be greater than the distance between the fittings to allow for the portions of pipe entering them. Therefore you first subtract dimension A of the fittings from the X-dimensions, but then add the distances that the pipe enters the fittings as given in Table Fig. 1.

Making threaded pipe joints: Before screwing pipe into a fitting or vice versa, use a stiff bristle or wire brush to clean chips and dirt from the threads of each. Next, smear some pipe-thread compound or "dope" over the threads of the pipe only, but not on the inside threads of a fitting as this causes it to collect on the end of the pipe and to restrict pipe diameter at this point, besides imparting a disagreeable

taste to water. Such a restriction interferes with the flow of water; also this forms a "drag" for building up a lime deposit that may eventually clog the pipe. Theoretically a watertight joint results from good threading and assembling, but there are slight variations that may result from threading, or there may be variations in the threads of fittings which can cause leakage at joints even though they appear tight. Therefore, it is general practice to use pipe-thread compound at all joints.

Defective fittings that are not tapped deep enough should not be used. Cutting a deeper thread on the pipe with an adjustable die in order to compensate for this only weakens the pipe by reducing its wall thickness, which may cause it to break later. It's better to replace the pipe, fitting or both. If threads fit properly a pipe can be screwed into a fitting, or vice versa, a distance of three or four threads by hand. A pipe wrench then is used to draw it up snugly. Often it is possible to attach or detach a fitting while the pipe is held in a vise as in Fig. 8. Generally, two wrenches are needed for assembling pipe, one on the pipe and the other on the fitting as illustrated in Fig. 9. Moderate pressure on wrenches should be sufficient. Excessive pressure may distort the fitting or squash the pipe. Exposed threads of iron or steel pipe joints should be coated with a suitable rust-resisting paint such as red lead or asphalt roofing paint.

Plastic pipe: Comparatively new but rapidly being accepted for many applications, strong, durable plastic pipe offers some specific advantages. It is extremely lightweight, from ⅛ to ⅓ the weight of metal pipe as evident from Fig. 10. It is rust, rot and corrosion proof; it can be cut with a saw or knife. Some kinds are especially designed to convey liquids intended for human consumption. Plastic pipe is entirely practical for jet wells and other cold-water plumbing installations, but it should not be used for hot-water lines or subjected to excessive heat.

The pipe comes in three forms — rigid, semirigid and flexible. Both the flexible and rigid kinds are shown in Fig. 11. The flexible pipe is ideal for installation in trenches as in Fig. 12. Available sizes range from ½ to 6-in. nominal inside diameters. The rigid pipe comes in 20-ft. lengths and is useful for well casings, septic-tank lines, field drainage, sprinkler and irrigation installations. The flexible pipe comes in coils from 100 to 400 ft. in length. It is especially suitable for jet wells and water-supply and distribution lines in locations free from rodent attack. Low temperature does not damage the pipe as it expands with freezing water.

Numerous fittings are available for both

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types so that any kind of connection can be made. Varying with the composition of the pipe, connections are made by insert couplings and clamps and insert adapters. Connections are also made by cementing the pipe into a fitting, which within a few minutes results in a joint as strong as the pipe itself. You can use compression fittings and also threaded joints. Threaded joints are practical for low-pressure or gravity lines but not recommended for vertical runs. In threading the pipe, it is recommended that a mandrel be inserted for support. The same threading equipment as for standard metal pipe is used. Plain or soapy water is used as a cutting solution—not oil or lead. The threaded pipe is assembled with strap wrenches; pipe wrenches will damage the pipe. No pipe-joint compound is required at the threaded joint.

Copper tubing: Copper tubing has thinner walls than copper pipe and costs less yet is sufficiently strong to withstand all pressures normally encountered in water-supply lines and thus offers practically the same advantages for home plumbing. Copper tubing is also easy to install and it can be run through closed partitions, Fig. 13, when replacing rusted-out iron or steel pipe, or when installing plumbing in a house not previously piped.

Copper tubing is furnished in three wall thicknesses (types K, L and M) for assembly with either solder or compression-type fittings. Type K is the heaviest and most durable. Type L has a slightly thinner wall. Both are furnished either hard in 20-ft. straight lengths, or soft in 60 and 100-ft. coils. Type M is still thinner than the other types of tubing of the same size. It is furnished only hard in 1¼ to 12-in. sizes and only in 20-ft. straight lengths, and is generally installed with soldered fittings, not being intended for use with compres-

DIMENSIONS OF K, L AND M-TYPES COPPER TUBING FROM ⅜" TO 2"

Nominal Size	Outside Diameter	Inside Diameter			Wall Thickness		
	Types K-L-M	Type K	Type L	Type M	Type K	Type L	Type M
⅜	.500	.402	.430		.049	.035	
½	.625	.527	.545		.049	.040	
⅝	.750	.652	.666		.049	.042	
¾	.875	.745	.785		.065	.045	
1	1.125	.995	1.025		.065	.050	
1¼	1.375	1245	1265	1291	.065	.055	.042
1½	1.625	1481	1505	1527	.072	.060	.049
2	2.125	1959	1985	2009	.083	.070	.058

(All Dimensions in Inches)

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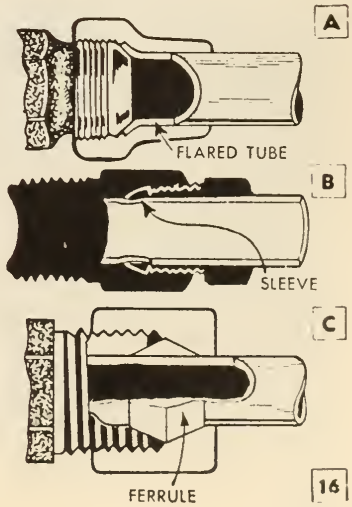
TYPES OF COMPRESSION FITTINGS



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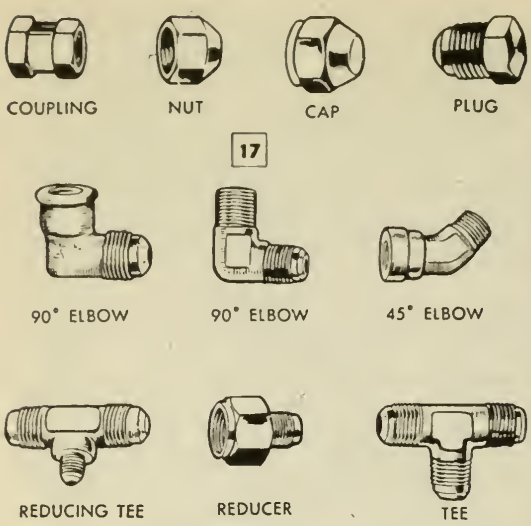

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sion fittings. Dimensions of copper tubing, of sizes from ⅜ to 2 in., are given in Fig. 15. In home plumbing, the hard variety is preferred for horizontal lines; soft tubing is difficult to install without sag between supports, which prevents good drainage of the system. Soft tubing is satisfactory for vertical risers.

For underground water service, as in Fig. 14, soft tubing of type-K thickness is recommended. Compression-type fittings are better suited mechanically to resist the settling movement of earth. The fittings should be tack-soldered for added security. The tubing should not be laid directly on stones or rock, and when filling the trench, a 12-in. layer of soft dirt is thrown over the tubing before adding stones for fill. Where copper tubing is embedded in cinders, it should be protected from the acid that is formed, This is accomplished by means of a layer of sand mixed with lime that extends well above and below the pipe.

Compression fittings: Fig. 16 shows three kinds of compression fittings for connecting copper tubing. The kind in detail A requires flaring the tube ends. The kind shown in detail B is assembled by merely pushing the tube into the fitting and then tightening the nut. This shears the sleeve from the nut and also compresses it tightly on the tube to which it then becomes permanently attached. Detail C shows a somewhat similar compression fitting in which a ferrule is also compressed on the tube. The ferrule has two tapers, one seating in the nut and the other in the body of the fitting. Fig. 17 shows a number of generally used fittings of the flared-tube type. The process of connecting tubes to them consists of cutting a tube off squarely, Fig. 18, and reaming off the burr inside and out, with a reamer or round file, Fig. 19. You then flare the end of the tubing after a sleeve nut has been slipped on, Fig. 20. The final assembly is

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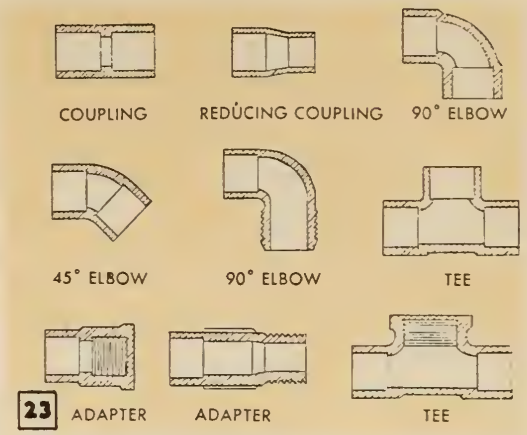

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shown in Fig. 21. The tool section contains data on using these tools. Flaring can also be done with a punch and hammer as in Fig. 22, particularly on tubing of larger sizes.

Solder-type fittings: Fig. 23 shows some solder-type fittings; a large variety of others are furnished also. To install them, the ends of the tubing are first cut off squarely, either with a tube cutter or with a hacksaw as in Fig. 24. Then the cut ends are reamed to remove the burr. Often a sizing tool also is used to correct any possible distortion of the tube caused by handling—

Next, the surfaces to be soldered together must be thoroughly cleaned, using emery cloth or steel wool, as demonstrated in Fig. 25, until the metal is bright. All traces of discoloration must be removed to assure uniform adhesion of solder. Wipe off all particles of dust and steel wool with a clean rag or brush, after which you apply a thin film of soldering flux completely covering both surfaces, Fig. 26. Paste flux is usually easier to handle for this purpose than liquid flux. Push the fitting over the tube as far as it will go and turn it back and forth a few times to assure getting the flux over the surfaces evenly.

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Heating comes next, using a blowtorch as shown in Fig. 27, or other type of torch. Direct the flame to all sides of the fitting if possible. While heating, touch the end of a length of wire solder to the edge of the fitting occasionally (outside the flame) to check for temperature. As soon as the solder liquefies instantly when touched to the fitting, the correct soldering temperature has been reached. Without waiting, feed solder between the tube and fitting by applying it all around the edge of the fitting, Fig. 28. The torch flame can be held on the fitting while solder is being applied to keep it hot. Generally the right amount of ⅛-in. solid-wire solder required is a length equal to the diameter of the tube. Kink the solder this distance from its end, and feed it up to this point. Solder applied at the edge of a fitting is drawn up between the contacting surfaces by capillary attraction, no matter at which angle the fitting is held. Solder even creeps up vertically this way for a greater distance than is required for making a good joint.

When applying solder, take care not to get it all over the tube or fitting. While solder is still liquid, you can use a rag or brush to wipe off any surplus, but leave it in the chamfer at the end of the fitting. Avoid movement of tube or fitting while the solder hardens; a disturbance at this time often causes weak joints. If the torch must be held near wood or other combustible material, protect the latter with a sheet of asbestos paper or asbestos board. An air-acetylene or liquefied-petroleum torch often is safer in such cases than a blowtorch as the flame is smaller.

To solder tubing into one or more outlets of a fitting already having a soldered joint, the solder in the existing joint is kept from melting by wrapping a wet rag around that portion of the fitting. Also, to disconnect a tube from a fitting without disturbing other soldered joints, use wet rags in the same way, as shown in Fig. 29. Large fittings require more care than small ones to heat them uniformly all around. This is particularly true with fittings of 2½ in. ir diameter and larger, such as copper vent waste tubes and soil tubes.

Kind of solder to use: A "soft" solder consisting of 95 percent tin and 5 percent antimony makes a considerably stronger joint than a 50-50 lead-and-tin solder. The former flows at temperatures in excess of 465 deg. F., and hardens at 450 deg., giving a plastic range of only 15 deg., which means quick hardening. This is desirable as it minimizes chances of poor adhesion caused by joint disturbance. Ordinary 50-50 lead-tin solder, customarily used by tinsmiths, melts at 250 deg. F., and has a 60-deg. plastic range. The best kind of solder for strong,

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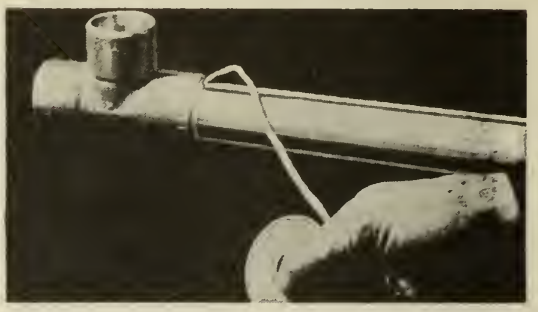

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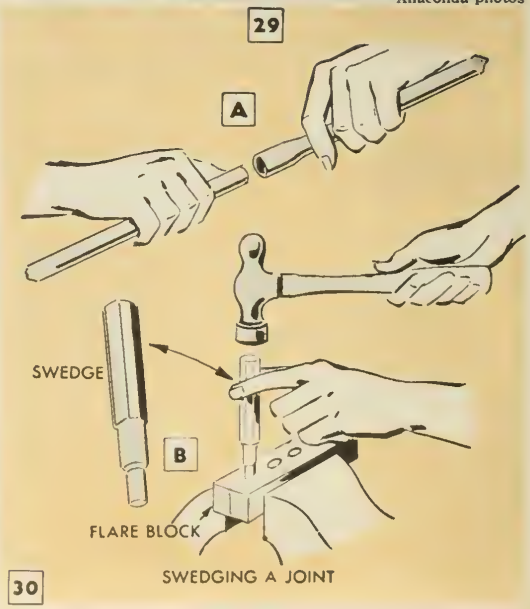

30 SWEDGING A JOINT

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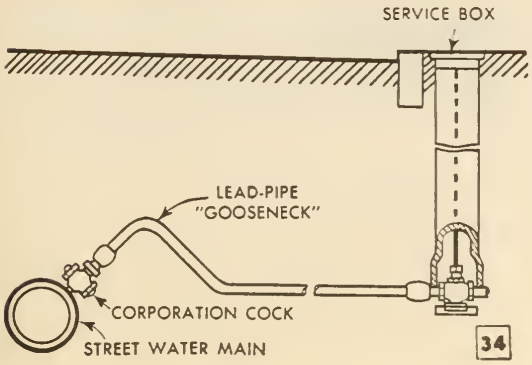
33 LEAD PIPE FOR VENT AND DRAINAGE LINES

I.D. (In.)	Wall Thickness (In.)		
1¼	118	139	171
1½	.138	.165	.191
2	.142	177	205
2½, 3, 4, 5, 6	.125		250



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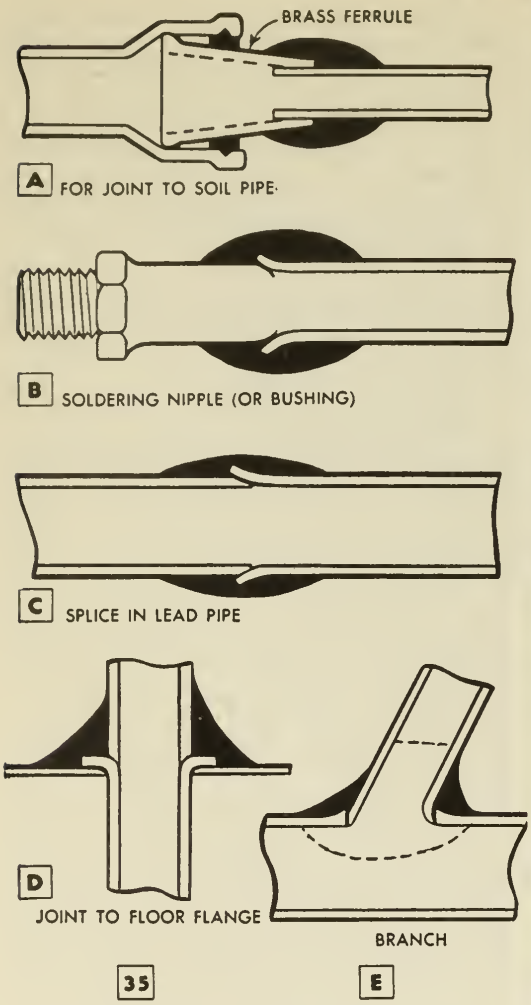
durable joints at fittings is "hard" solder consisting of copper and phosphorus, sometimes with silver added, which flows at temperatures from 1300 to 1400 deg. F.

Bending copper tubes: It is often necessary to bend tubing to pass ordinary obstructions in building construction. Soft tubing is generally used for this. Use a bending spring to prevent kinks. Hard tubing requires annealing (softening) the portions to be bent. This can be done by heating the portion of tubing to a dull red with a blowtorch. Applying cold, soaked rags to the heated portion helps annealing and cools the metal quickly.

Swedged copper-tube joints: Two lengths of soft copper tubing (or hard tubing annealed at the ends) of equal diameter can be joined by swedging instead of using a coupling. The end of one length is expanded to fit over the end of the other as in Fig. 30A. Then they are sweat-soldered together. To make such a joint the ends are first cut off squarely and reamed to remove burr. Then a swedging tool of proper size is driven into the end of one length while held in a flare block which is clamped in a vise, as in detail B. The tool is driven in up to its shoulder. After cleaning the surfaces to be soldered to a bright finish, using emery cloth or steel wool, flux is applied and sweat-soldering is done as previously described under "Solder-type fittings." A swedged joint should not be made where a bend is to be located, as the double wall thickness will make bending difficult. Also, a swedged joint should not be made within 4 in. from an end which is to be flared, as the joint will interfere with clamping the tube in the flare block.

Lead pipe: Lead is subject to less corrosion than other metals commonly used for drainage lines. The original lead plumbing of many early American homes is still in use today. Being flexible, lead pipe is particularly suited where building settlement, vibration, or expansion and contraction impose a strain on plumbing fixtures and rigid pipe connections: for example, bathtubs and water closets. Lead waste, vent and drum-trap connections remain watertight under normal conditions. Fig. 32 shows a lead bend installed between a water closet and rigid soil pipe. As lead pipe is easily bent for changes of direction, and can be installed without bulky joint connections and intricate pipe fitting, its use is especially desirable in restricted spaces.

Lead pipe that runs horizontally should be supported, its entire length if possible, by using wooden strips or metal troughs fastened to joists or hung from ceilings with hangers. Vertical runs should be supported at intervals of about 4 ft., using tabs sol-



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Lead Industries Assn. photos

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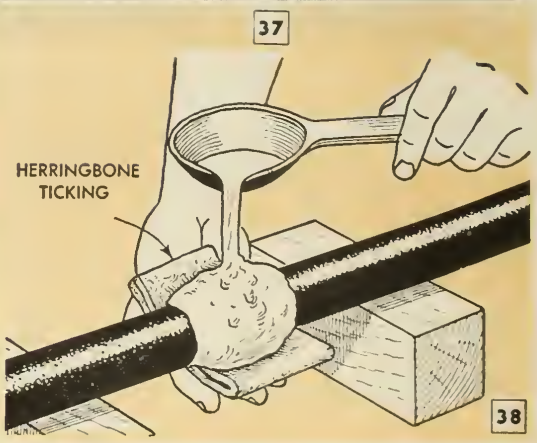

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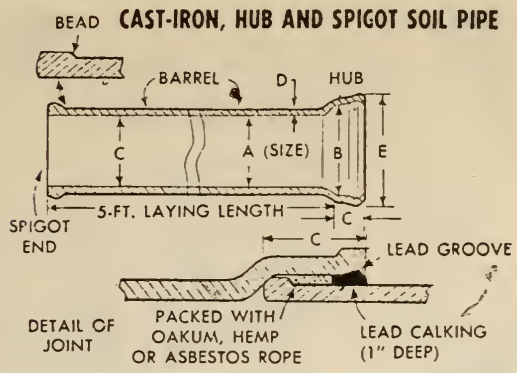
dered to the pipe. Fig. 33 gives the sizes of lead pipe used for vent and drainage lines. Sheet lead and lead pipe are in general use for flashing and enclosing vent terminals that project above roofs. In Fig. 31, flashing on a flat roof, laid before roofing, is soldered to the lead joint of the soil pipe. Often lead pipe fitting around the vent terminal is soldered to the flashing and the upper end is turned over the edge of the terminal, making a completely leakproof assembly.

Another common application of lead pipe in heavier wall thicknesses is for "gooseneck" connections between city water mains and house-service pipes as in Fig. 34. These connections are commonly used in many cities. Alkaline water in contact with lead produces a coating of insoluble lead carbonate, which prevents this water from dissolving lead and becoming toxic. The opposite is the case when lead pipe is used for soft water containing dissolved oxygen, carbon dioxide and organic acids. Therefore lead pipe is not recommended for use as water supply and distribution lines where the water is to be used for drinking and cooking purposes.

Connecting lead pipes to iron pipes: Fig. 35 shows a number of lead-pipe joints, all of which are made by wiping molten lead around the connection. Detail A shows how a lead pipe is attached to soil pipe by means of a brass calking ferrule. A lead closet sleeve or bend is connected to the hub of



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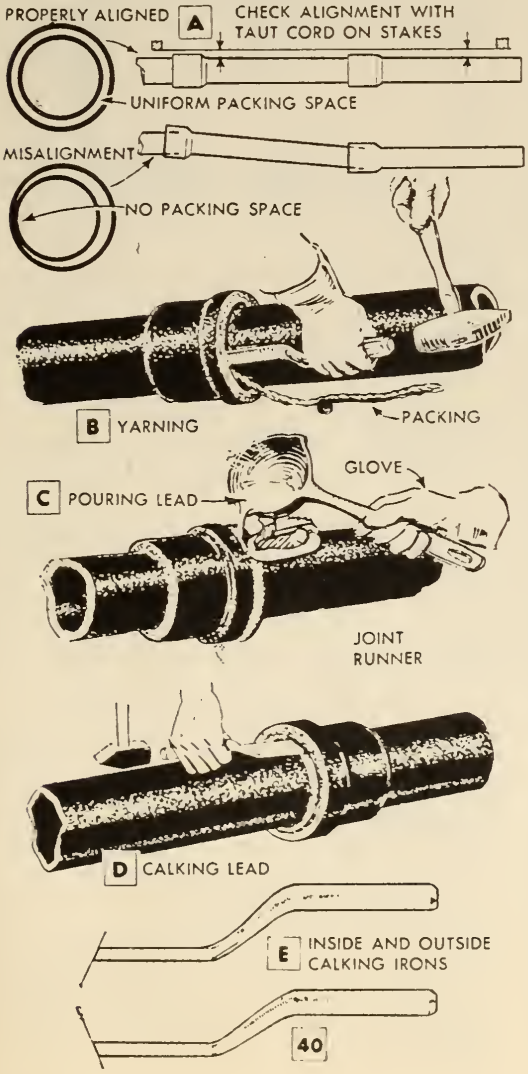
DATA ON 2" TO 6" SERVICE-WEIGHT (CLASS B)*

Nom. Size A	Dimensions (In.) B	C	D	E	Lbs. Per Joint Oakum	Lead
2	2.94	2.44	.10	3.68	.21	1½ - 2
3	3.94	2.68	.12	4.80	.31	2¼ - 3
4	4.94	2.94	.12	5.80	.42	3 - 4
5	5.95	2.94	.12	6.80	.52	3¾ - 5
6	6.94	2.94	.12	7.80	.63	4½ - 6

* Also Furnished in "Extra-Heavy" Weight



soil pipe of the same size by means of an iron Ferrule, which is driven into the pipe, then joint is leaded. Fig. 35B shows lead pipe attached to a brass soldering nipple with which connection is made to a threaded pipe fitting. Soldering bushings are similar except that pipe screws into them. The lead pipe slips into, over or against the ends of these fittings, after which the two are joined with a wiped joint. Joints of lead pipe to brass and copper pipe are made in the same manner. Detail C shows an end-to-end joint in lead pipe. Note how one edge is tapered on the outside so that it fits snugly into a flared and chamfered inside end of the joining length. Tapering is done with a rasp and flaring with a bell-shaped wooden plug of proper size driven into the end of the pipe with a hammer. Detail D shows a joint to a floor flange, and detail E shows a branch connection joined at an angle.

Wiped joints: A wiped joint must have an exposed surface extending not less than ¾ in. on either side of a joint, and the thickest portion should not be less than the thickness of the materials being joined. To make a good wiped joint requires skill and practice. It is done by thoroughly scraping the surfaces to be covered so that they are bright after a coating of plumber's soil (mixture of lampblack and glue) has been applied and allowed to dry. Then saltless mutton tallow is rubbed on the lead surface, and soldering flux on the brass or copper surface, these having been previously cleaned with emery cloth or steel wool. The tallow keeps the lead from oxidizing and also acts as a flux for molten solder, which is poured on slowly from a ladle as in Fig. 36. Although not shown, gloves should be worn. A wiping pad (herringbone ticking folded to several thicknesses) is held under the joint to catch the solder running down and at the same time to shape the joint. Grease on the wiping pad will prevent solder from adhering to it. After the solder joint has been built up, the surface is wiped smooth as in Fig. 37. It is easier to make a wiped point when the pipe is horizontal, in which case it can often be laid on blocks as shown in Fig. 38. A good solder for wiped joints consists of 37 percent tin and 63 percent lead. When melted for application, it should be just hot enough to scorch a piece of paper.

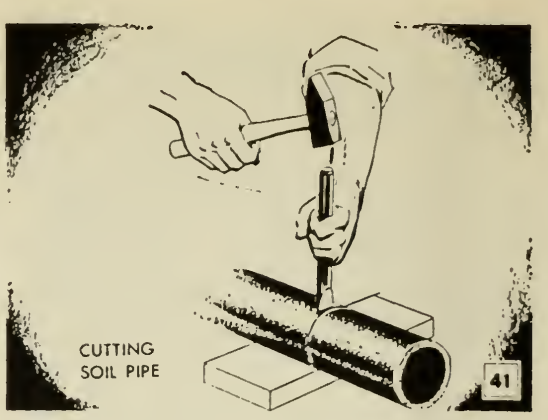
Cast-iron hub-and-spigot soil pipe: Coated with coal-tar pitch to make it acid-resisting, cast-iron soil pipe of the hub-and-spigot type, Fig. 39, is most commonly used for underground drainage lines within a building; also this type can be used for the soil stack and the drainage lines from water closets to the stack. Often this pipe is

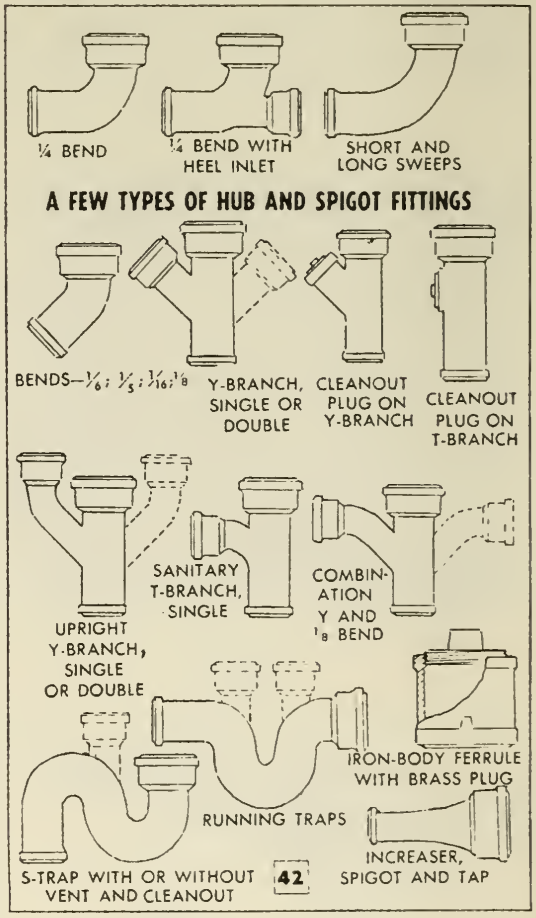
used also for house sewers. It is furnished in 5-ft. lengths (laying lengths), in sizes from 2 to 15 in. nominal inside diameter. The 3 to 6-in. sizes are most common. Lengths having a hub at each end are furnished also. These are convenient and economical since two short lengths of pipe can often be cut from one double-hub length instead of cutting these from two regular lengths.

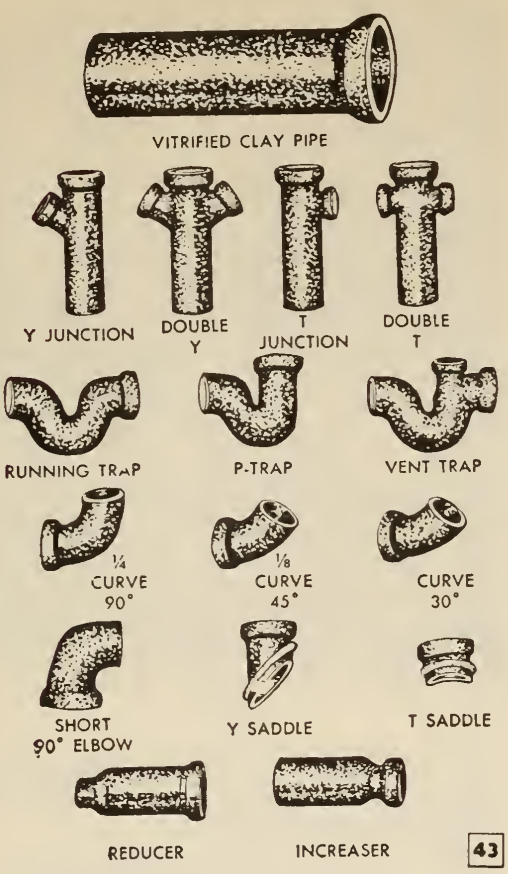
Assembling soil pipe: When assembled, the spigot end of the soil pipe faces the direction of flow and fits into the hub end (also called "bell" end) of the next length. Before joining pipes, each length should be tested by striking it lightly with a hammer at the ends. A clear bell-like ring indicates that the pipe is not cracked. The spigot end has a bead which fits snugly into a hub so that packing material will not be forced inside the pipe. Joining ends should be thoroughly clean and dry, and the two joining lengths should be in perfect alignment, which can be checked with a taut cord tied to two stakes as in Fig. 40A. Misalignment in length causes misalignment at joints so that the space between pipe and hub (annular space) is not uniform in width.

The proper method of making a good joint starts with a packing of oakum, hemp or asbestos rope, which is wrapped around the pipe and is driven down with a yarning iron and hammer as in detail B. Work around the pipe evenly so that the packing is not forced tightly on one side while it is still loose on the other. This causes the pipe to shift off center. The packing should come to an inch from the rim of the hub to leave enough space for leading, which anchors in the hub groove. Strands of the packing should not project out of the hub as this may cause leakage. For pipe laid horizontally you need an asbestos joint runner to hold molten lead in the joint, detail C. Its use is explained in the tool section. A joint runner is not needed when pouring lead into a joint on vertical pipe.

Calking lead is used for this purpose, obtainable in 3 to 5-lb. cakes and in 90 to 100-lb. pigs. Amounts of lead and oakum required for filling soil-pipe joints are given in Fig. 39. The lead is melted in a fire pot. Correct temperature for pouring is indicated when the molt becomes cherry red. Then a ladle is used to pour the joint as in Fig. 40C. Before melting lead and using a ladle read instructions and precautions contained in the tool section. The entire joint should be filled at one pouring. When the lead hardens, the joint runner is removed. As lead shrinks slightly upon cooling, it must be tamped into firm contact with the pipe and hub, detail D. For this you use a light hammer and calking irons as shown in detail E. Avoid heavy blows which may loosen rather than tighten the lead ring. Go around the joint with an "inside" calking iron to pack the lead against the pipe and an "outside" iron to pack it against the hub. When molten lead cannot be used, as for example under water or where the use of an open flame is dangerous, lead wool, which comes in ropelike form, is used. This is simply packed into a homogeneous ring, without the need of heat. Some codes, however, do not permit its use as a substitute for melted-lead joints in ordinary soil-pipe installations.







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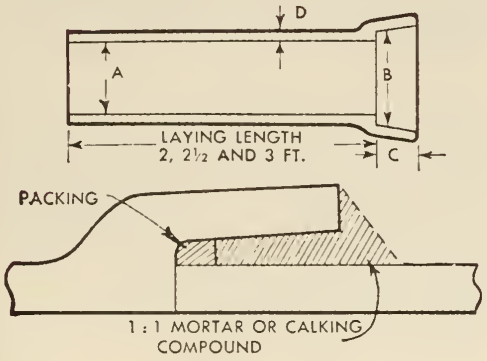

DATA ON STANDARD-STRENGTH VITRIFIED-CLAY PIPE

Size A	B	C	D	E	F	G	H
4	5 3/4	1 3/4	1/2	9	1430	.074	.44
6	8	2 1/4	5/8	15	1430	.234	86
8	10 1/2	2 1/2	3/4	24	1430	.365	1.13

E AVERAGE WEIGHT PER FT. OF LENGTH.
F CRUSHING STRENGTH PER LINEAL FT. ON SAND-BEARING PIPE.
G POUNDS OF JUTE (AT 25 LBS. PER CU. FT.) REQUIRED PER JOINT.
H POUNDS OF ASPHALT JOINT COMPOUND (AT 90 LBS. PER CU. FT.) REQUIRED PER JOINT.

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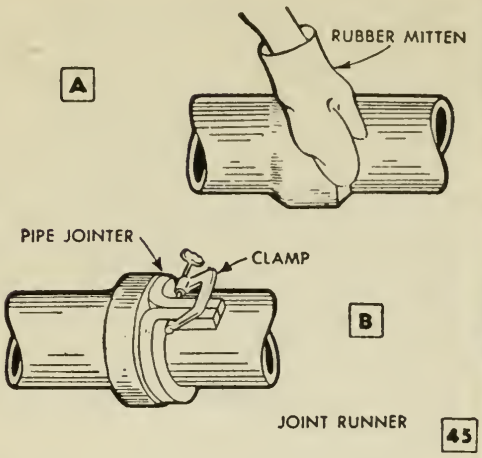
Cutting soil pipe: A cold chisel and a hammer are used to cut soil pipe as shown in Fig. 41. First the pipe is marked with chalk so that the cut end will be square. Then the pipe is scored all around by tapping the chisel lightly. In doing so the chisel should be pointed toward the center of the pipe and moved forward in overlapping steps for successive blows. After scoring the pipe, it is placed on a support such as a wooden block or sandbag set directly under the point of cutting, and it is struck with increasingly heavier blows along the score. An even break usually occurs after circling the pipe a few times. Actually the pipe is not cut through but the narrow strip of metal along the score is weakened until it breaks. The same method is used also for vitrified-clay pipe.

Cast-iron soil-pipe fittings: Fig. 42 shows a variety of fittings for cast-iron soil pipe. These have ends to match the pipe and are joined in similar manner. For changes of direction, bends and sweeps are used. Their angle is not designated in degrees but by fractions of 360 deg. Thus a 90 deg. turn is called a ¼ bend; a 60 deg. turn a ⅙ bend; a 45 deg. turn is a ⅛ bend. Long-sweep turns offer least resistance to the drainage flow.

Vitrified-clay pipe: The smooth surface of vitrified-clay pipe does not wear or corrode, being inert to acids, alkalies and solvents. Other advantages of this pipe are its low cost, simplicity of installation, and its permanence when not subjected to abnormal strains that may crack or break it. It is furnished in 2, 2½ and 3-ft. laying lengths; in 4 to 36-in. nominal inside diameters; in two grades (standard and extra-strength); and in straight and curved lengths of various shapes, some of which are shown in Fig. 43. One end of each length is a hub or socket and fits over the spigot or plain end of an adjacent length as in Fig. 44, which also gives data on this kind of pipe as well as the amount of jute and calking compound required per joint.

Vitrified-clay pipe can be cut in the same way as cast-iron soil pipe. It can be connected to the latter of same size by using an increaser. Joints can be sealed with portland-cement mortar, or with asphalt-base jointing compounds. The ends should be thoroughly cleaned and free from grease or oil. After carefully aligning two adjoining lengths, the spigot end being inserted as far as possible in the hub, you lightly tamp in enough oakum or jute, about ½ in. thick, to seal the joint so that cement or melted compound will not seep through to the inside. The packing is done evenly from all sides to keep the joining sections in concentric alignment. Often packing is omitted, and only a rather stiff mortar is used, in which case the pipe is swabbed out.



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Mortar joints: After packing a joint with oakum, force into the joint a 1:1 mix of clean, sharp sand and portland cement, with just enough water added to make a rather stiff paste that will not run. A wooden calking tool will help to push the cement down solidly into the joint. The surplus is rounded off neatly with a trowel or a rubber mitten as in detail A of Fig. 45. Often two or three lengths of pipe are set up vertically, Fig. 46, for making joints with mortar that is plastic enough to be poured. This leaves fewer joints to be made in the trench. After letting the cement harden overnight, the pipe is carried by a stout pole slipped through it, after which it is lowered into the trench and joined to other similar lengths.

Other jointing compounds: A number of asphalt-base and other compounds are available for making good joints that remain slightly flexible and resist root penetration. Most of these compounds are poured while hot into thoroughly clean and dry joints after tamping in a seal of jute, oakum or asbestos rope. The melted compound can be poured into joints when several lengths are stacked vertically as in Fig. 46, but when joints on horizontal lengths are poured, a "joint runner," detail B, Fig. 45, or a clay dam is used. Compounds should be used in accordance with manufacturer's instructions. If they are overheated or kept hot too long they may become brittle. If not sufficiently heated, they may harden before the joint is completed. During cold weather they may not adhere effectively unless the pipe jointing is preheated.

Concrete pipe: Also shaped with hub and spigot ends, concrete pipe that is used for drainage purposes comes in 2, 2½, 3 and 4-ft. lengths, and in 4 to 24-in. nominal inside diameters. It is assembled in the same way as vitrified-clay pipe. Concrete pipe is subject to attack by acids and is not as durable as vitrified-clay pipe for use as sewers, although its cost is approximately the same.

Asbestos-cement pipe: This pipe is hard, dense and strong, as the mixture from which it is made—asbestos fiber, portland cement and silica—is subjected to heavy pressure during manufacture. Being durable and highly resistant to corrosion, this pipe has been found successful as vent and sewer pipe. It is furnished in 5 and 10-ft. lengths, the advantage of the latter being that fewer joints are required. Although sizes range from 6 to 36 in. in diameter, the smaller sizes, from 2 to 6 in., are used for house sewers, Fig. 47, and vent pipes, Fig. 48.

Ends of the pipe are machined to take couplings of the same material. The use of special rubber rings between couplings and pipes, as shown in Figs. 49 and 50, gives a tight, flexible joint especially designed to overcome leakage and root penetration. Pipe and couplings are easily assembled by pressing them together as shown in Fig. 51, using the simple arrangement shown in Fig. 52.

A number of T and Y branches are furnished, as well as elbows, bends and special adapters to make connections to other pipes such as soil pipe. Where short lengths are required to make closures, the pipe can be sawed off with a carpenter's saw. Adapters are also furnished to join such a cut end to a machined end, or to join two cut ends together. In this case a seal is

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Johns-Manville photos

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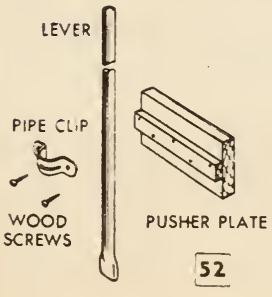

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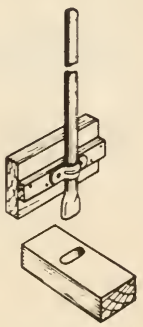
PARTS FOR ASSEMBLY TOOL

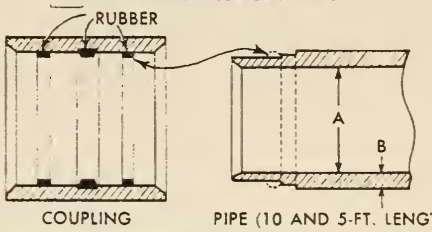


ASSEMBLED TOOL

made with cement, lead or other commercial jointing compound. Fig. 53 gives some data on dimensions and weight of house sewer and vent pipes made of asbestos cement.

Porous and perforated pipe: For disposal lines of septic tanks and for rapid drainage of ground water, porous drain tile is most extensively used. It comes in 1-ft. lengths and the 4 to 6-in. sizes are most common. The pipe is of uniform diameter and has no hub. The lengths are laid end-to-end, with tar-paper squares over the joints to prevent entrance of soil. Perforated pipe of vitrified clay and bituminized fiber is also made for this purpose.

53 ASBESTOS-CEMENT PIPE



COUPLING

PIPE (10 AND 5-FT. LENGTHS)

Nom. Size A		Thickness B	Weight C	Strength D
Sewer Pipe 1	Vent Pipe 2			
4		.27	4.7	1740
5		.30	6.3	1680
6		.30	7.5	1420
	2	.30	2.2	
	3	.32	3.2	
	4	.32	4.2	

1—PIPE FOR HOUSE-TO-SEWER CONNECTIONS; SIMILAR PIPE ALSO FURNISHED UP TO 36" DIA., IN TWO CLASSES AND IN 13-FT. LENGTHS

2—PIPE FOR VENTS IN HOUSE PLUMBING; HAS DIFFERENT STYLE JOINT THAN ONE ILLUSTRATED. OTHER PIPE FURNISHED FOR FLUES

C—WEIGHT IN LBS. PER FT. PER 10-FT. LENGTH WITH COUPLINGS

D—MINIMUM APPLIED LOADS (LBS. PER FT.) FOR CRUSHING TESTS

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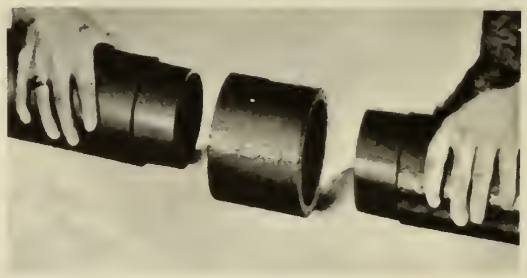
Bituminized-fiber pipe: Fiber pipe has been successfully used for many years for numerous purposes such as house sewers, outside downspouts, conductor pipe for irrigation and for farm and ranch gravity-type water supply and distribution lines. It is impregnated throughout with coal-tar pitch, is lightweight, non-corrosive and slightly flexible, which allows it to absorb shocks, earth tremors and normal soil movement without cracking, shearing off or pulling out at the joints. Sweeps of 45 and 90 deg., as well as numerous other fittings are furnished. Fig. 54 shows this pipe used in a house-sewer installation.

The pipes have tapered ends which are joined to couplings having slight inside tapers to match, Fig. 56. Driven together simply by using a block and hammer as in Fig. 57, the joints are so tight that tree roots cannot enter. Connections can be made to other pipes, either the threaded or the hub-and-spigot type, by means of special adapters. Joints to cast-iron soil pipe are sealed with flexible jointing compounds, molten lead or lead wool, as previously described under cast-iron and vitrified-clay pipe. Fig. 55 shows how an ordinary handsaw is used to cut fiber pipe to any length. A special cutter is required to taper ends cut in this manner, but where such a cutter is not available, these ends can be tightly sealed in a special coupling with the aid of jointing compound. Fig. 58 gives dimensional data on the smaller sizes of bituminized-fiber pipe.

Methods of supporting pipe: Pipes and tubing used in a plumbing system must be installed with adequate support to prevent undue strains and stresses on it. In a building, pipe is "hung" in pipe supports so that contraction, expansion and settling of the building will not break the pipe or place a strain on it. Pipe should not be attached rigidly to a building. Fig. 59 shows several



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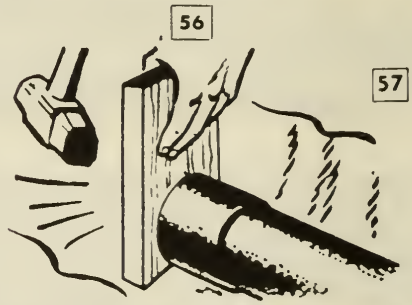

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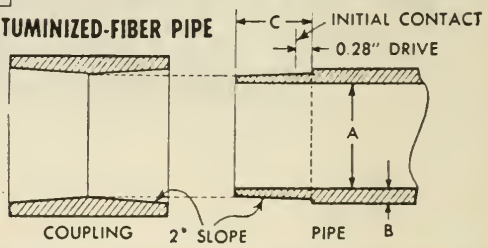
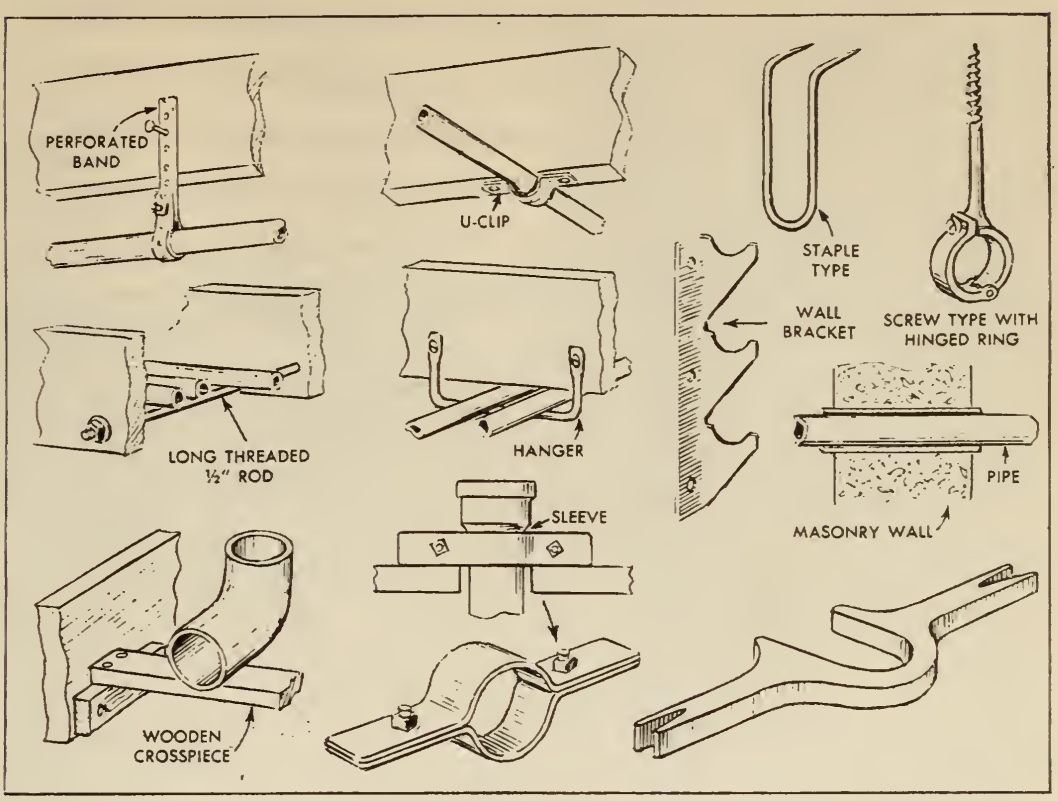
BITUMINIZED-FIBER PIPE



SIZE A (In.)	THICKN. B (Min.) (In.)	C (In.)	Length (Feet)	Weight D	Strength E
2	.23	1.43	5	1.24	1100
3	.28	1.69	8	1.71	1100
4	.32	1.94	8	2.66	1100
5	.41	1.94	5	4.44	1300
6	.46	1.94	5	5.78	1300
8	.57	2.48	5	9.81	1600

D—Weight Per Ft. Including Couplings
E—Crushing Strength Between Two Flot Plates



methods of supporting pipes. The use of pipe straps is the most common. Spacing of the supports must be such that the pipe will not sag. Screwed pipe should be supported at intervals not over 12 ft. Copper tubing should be supported at intervals not over 6 ft. for piping 1½ in. and smaller, and not over 10 ft. for sizes 2 in. and larger. Supports for cast-iron soil pipe should not be spaced more than 5 ft. apart, and should be placed as near to the joint of the pipe as possible. Lead pipe is laid on strips of wood or metal, or is otherwise suitably supported its entire length.

Vertical lengths of pipe may be supported by collars, yokes or tabs. Distances between such supports should not be more than one-and-one-half-story height for screwed pipe, one-story height for cast-iron soil pipe, one-story height for copper tubing 1½ in. and over in size. For copper tubing smaller than 1¼ in., and also for lead pipe, the spacing between supports should not exceed 4 ft.

Pipe hangers should be attached securely to the building construction, using nails, screws or bolts in wood, and screws or bolts driven into metal expansion sleeves for proper anchorage in masonry. Attachment of hangers to wooden plugs driven into holes drilled in masonry is not dependable as the plugs may shrink and loosen. Buried pipe should be laid on compact earth. In filled and other unstable earth, pipe other than cast-iron soil pipe should be supported on concrete pads suitably spaced to prevent settling.

Dimension Table for Standard Pipe Minimizes Measuring Errors

When making plumbing or heating repairs in the home, costly waste of pipe is likely to result from inaccurate measurements, such as, forgetting to allow for the threaded ends of the pipe inside the fittings. This table, which gives pipe diameters and thread lengths in fractions of an inch, will help you obtain correct measurements.

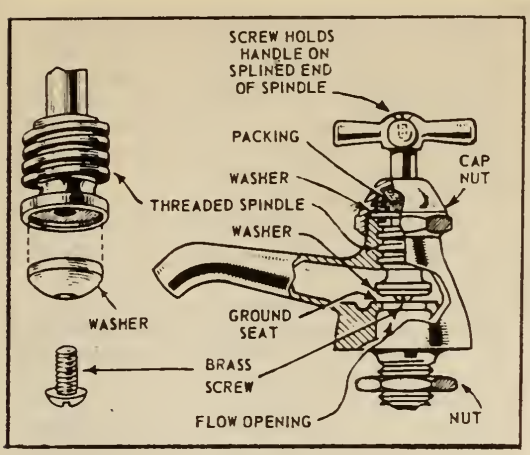
PIPE SIZE	⅛"	¼"	⅜"	½"	¾"	1"	1¼"	1½"	2"
INSIDE DIAMETER	9/32"	3/8"	½"	5/8"	13/16"	1 1/32"	1 3/8"	1 5/8"	2 1/16"
OUTSIDE DIAMETER	13/32"	17/32"	11/16"	27/32"	1 1/16"	1 5/16"	1 21/32"	1 29/32"	2 3/8"
APPROXIMATE THREAD LENGTH ONE END	¼"	3/8"	3/8"	½"	9/16"	11/16"	11/16"	11/16"	¾"
APPROXIMATE THREAD LENGTH BOTH ENDS	½"	¾"	¾"	1"	1 1/8"	1 3/8"	1 3/8"	1 3/8"	1½"

PLUMBING REPAIRS MADE SIMPLE
Water-System Troubles and Cures

MOST WATER-SYSTEM TROUBLES can be prevented by proper servicing, such as keeping faucets and valves in good condition, renewing air in air chambers, protecting pipes against frost, and avoiding scale accumulations by water-softening equipment. Inherent troubles that are due to faulty installation may necessitate replacement of pipe and fittings. Substitution of larger pipe may also be necessary to take care of added demands.

Faucet noises: Chattering and whistling at faucets are among the most common noises. When this occurs with a compression-type faucet as shown in Fig. 1, look for a loose or defective internal assembly. Often the trouble is caused by a loose washer, which can produce chattering by alternately closing and freeing the water flow when turned on slightly. To remove the faucet spindle assembly, first turn off the water supply, then wrap the cap nut with cardboard or cloth to protect its finish when loosening it with a suitable wrench—not a pipe wrench or pliers. Back off the cap nut entirely and unscrew the spindle assembly in the same direction as the handle turns when opening the faucet. Check the small screw holding the washer on the end of the spindle. If loose, tighten it so that the washer is seated firmly. If the washer is worn, replace it with a new one. When screwing the spindle assembly back into the faucet, carefully check whether there is any up-and-down play caused by wear on the threaded parts. If so, replace the spindle with a faucet insert.

Chattering and whistling noises may occur also in faucets and valves of poor hydraulic design, especially cheaper ones, due to a small, restricted waterway. When a water passage is restricted, the velocity of flow through the restricted passage is increased. When fast-moving water changes in direction, centrifugal force creates a vacuum at the inside of the turn and may



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cause vapor bubbles to form. When these collapse the vibration results in noise; if the vibration is of high frequency, whistling results; if of low frequency, chattering and pounding result. Where such noise in faucets and valves is inherent due to poor design, about the only remedy is to replace them.

When noise occurs in a Fuller-type faucet (see *Faucets*), which is now practically obsolete but still is found in old plumbing systems, the body of the faucet is unscrewed from the tailpiece. The ball inside may be loose and require tightening, or the ball shaft and spindle eccentric may be worn, permitting the assembly to rattle.

Water hammer in pipes: Hammering noises in pipes that occur when a faucet or valve is closed suddenly are also extremely common. The momentum of fast-moving water in a pipe, particularly in a long horizontal pipe where water has considerable velocity, causes a shock wave when suddenly arrested. The shock wave travels back and forth between the faucet or valve and the point where the pipe changes direction or connects to a larger pipe or to a tank. The hammering that this causes can also shake the pipe violently. Such strain can result in rupture of the pipe at fittings, or the fittings themselves can crack. This is one reason why only malleable-iron fittings should be used on water pipes. Sometimes the noise is less pronounced when the pipe is anchored securely, but the same pressure is created by the shock wave and may still be injurious to the plumbing system although perhaps to a lesser extent. Water hammer is most pronounced when it occurs in hard, rigid pipe such as iron, steel or brass. It is less noticeable in flexible pipes such as copper, lead and especially plastic pipe, as it is very flexible and offers relief from pressure.

Since the trouble is occasioned by sudden

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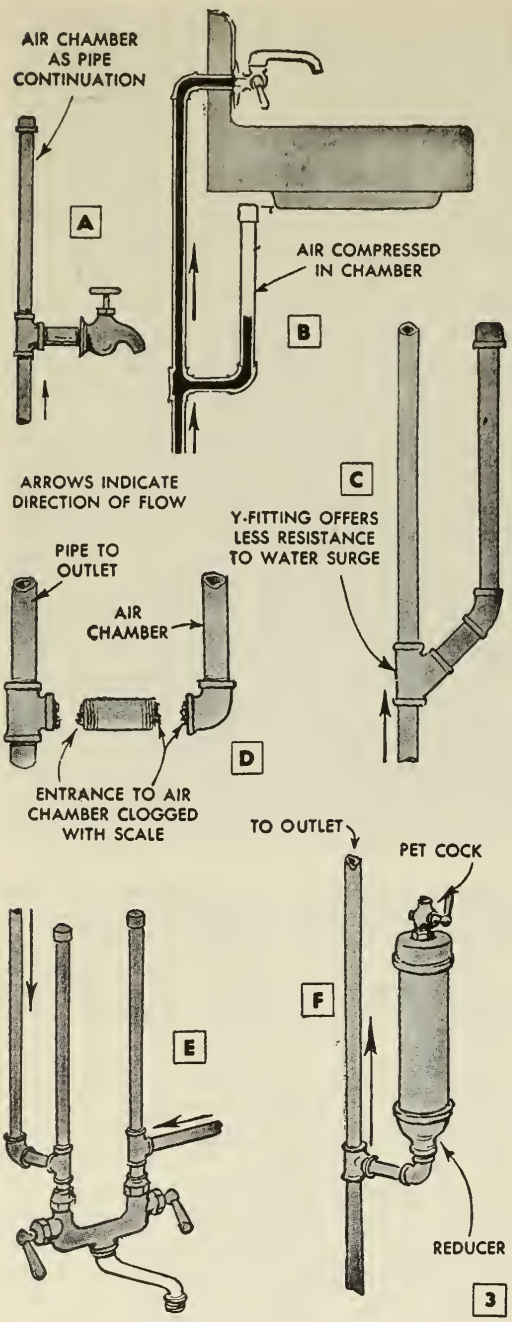
closing of faucets and valves during the last 15 percent of the closing swing, it can be eliminated by closing them slowly. It cannot be prevented in quick-acting automatic valves generally, or in self-closing faucets. Any or all of the three following methods are used to reduce or eliminate water hammer: (1) Proper servicing of existing air chambers, or the installation of larger ones; (2) by using a pressure-reducing valve or regulator; (3) by providing braces to prevent pipe movement.

Servicing air chambers: In every well-designed plumbing system, air chambers are installed near outlets as in Figs. 2 and 3. The purpose is to provide a pressure relief. When faucets or valves are closed quickly, water rushes into the air chamber. As air is compressible it cushions the water thrust to a more gentle stop and thus causes less shock. However, since the air cushion is gradually absorbed by the water under pressure, more air must be provided periodically. This is done by draining out the water that replaces the air in a waterlogged air chamber as follows: First shut off the water supply to the air chamber at the nearest branch control valve, then open a drain valve below the level of the air chamber. If the air chamber is located above the faucet level as in the case with those



on basement laundry tubs, Fig. 2 and Fig. 3E, the faucet will serve as a drain. If the air chamber is accessible, remove the cap on the upper end to assure that water will run out—especially from small pipes which sometimes retain water unless it is so released. If there is any evidence of scale and corrosion in pipes, the air chambers should be removed occasionally to check whether they are open. Sometimes they become clogged, especially in short horizontal parts, detail D. When reassembling, wipe some pipe-joint compound or white lead on the threaded ends of the pipe to assure air-tight joints, but avoid getting this inside of the fittings or it may taint the water. It may also start an obstruction. Repeat the process for both hot and cold-water outlets. If a pipe cap fits too loosely, wrap the threaded end of the pipe with a strand or two of cotton string or No. 40 cotton thread.

An air chamber that requires frequent attention can be made more convenient to drain by adding a petcock on the cap and a T-fitting with a plug or petcock at the bottom. Another method of servicing an air chamber is to install a tire valve on the cap so that air can be replenished by using a bicycle pump. When the supply of water to an individual faucet or valve can be shut off at a point close to the air chamber, you can remove the air chamber to drain it.

Air-chamber design: The capacity of an air chamber should not be less than 1 percent of the capacity of the pipe line in which water hammer occurs. For the average home, air chambers should not be less than 18 in. long. They should be made of 1-in. pipe when installed on ½-in. water lines, and of 1¼-in. pipe when installed on ¾-in. lines—two pipe sizes larger than the line. See Fig. 3F. Air chambers are set vertically; they may be a continuation of a riser as in detail A, or can be offset as in details B, C, E and F. Where possible, an air chamber arranged as a continuation of the pipe is best as it receives the full thrust of the water. For offset arrangements, 45-deg. fittings, as in detail C, offer less resistance to thrust than 90-deg. fittings. The direction of flow may be downward, as in detail E, but in all cases the opening to the air chamber is at its bottom. It has been found that the effectiveness of air chambers is measurably increased if the inlet opening is restricted to about one-half the internal diameter of the water pipe to which the air chamber is connected.

Pressure-relieving devices: There are also a number of commercially made shock absorbers which serve the same purpose as air chambers. Some of these have metal bellows; others, like the one in Fig. 4, have spring-loaded diaphragms. This type requires only a few inches of vertical space and is very convenient for use where overhead clearance is limited. Among the advantages of these shock absorbers are that they require much less space than air chambers and do not require periodic draining like the latter.

Location of air chambers and shock absorbers: Air chambers may be installed in partitions near the outlets they serve. They can also be located under the outlets, as in cabinets under kitchen sinks, or they may be located in an accessible position above outlets, as with faucets on basement laun-

dry tubs. Where water hammer occurs in the service line from street to house, a large air chamber, having provisions for venting and draining, should be located at the service-line entrance as shown in Fig. 5. When long, horizontal pipes require air chambers or shock absorbers these are installed at the end toward which water flows.

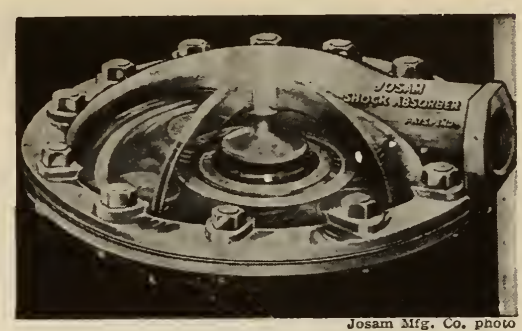
Pressure-reducing valves: Where water pressure is high, a pressure-reducing valve or pressure regulator, described under *Valves and Faucets,* can be used to reduce or eliminate water hammer. By reducing the pressure, the velocity of water flow is slowed down and less shock is produced when faucets and valves are closed suddenly. If the trouble is not entirely cured by means of such a regulator, air chambers or pressure-relief devices may be installed also.

Pipe supports: Excessive lengthwise movement of long horizontal pipes can be avoided by supporting them firmly as shown in details A, B and C of Fig. 6. Such support does not in any way reduce the shock wave caused by closing faucets and valves suddenly, and therefore does not prevent possible injury to them. As the pipe is braced at the end toward which water flows, movement in the opposite direction due to expansion and contraction is not restricted.

Rattling of loose pipe against walls or joists can be prevented by proper support. Strap-type pipe hangers should be attached securely to the pipe; they can swing slightly to allow for pipe expansion. Pipe clips of the kind shown in detail D are used for supporting risers. They should not be used for attaching pipe to joists; then vibration is conducted to floors and noise is intensified. On concrete walls, pipe is attached at suitable points to blocks as shown.

Noises from water heaters: Rumbling and pounding noises sometimes originate from water heaters or from the pipes between heaters and tanks. If a water heater is not properly protected by means of a safety-relief valve, or if the valve is not functioning, such noises may be caused by overheated water. The heater should be turned off at once and the relief valve checked. Some relief valves have test levers operated manually to make this check.

Noises in a water-heating system that is properly protected may also be due to poor circulation between the heater or furnace water back and the storage tank. Heavy liming of a heater coil or furnace water back, or the pipe from heater to storage tank, particularly at fittings, may restrict the circulation so much that steam pockets are formed. When these come in contact with the colder water of the tank, they collapse and cause hammering. The same can occur when a furnace coil is not level. This may loosen or break pipe joints and cause leakage.



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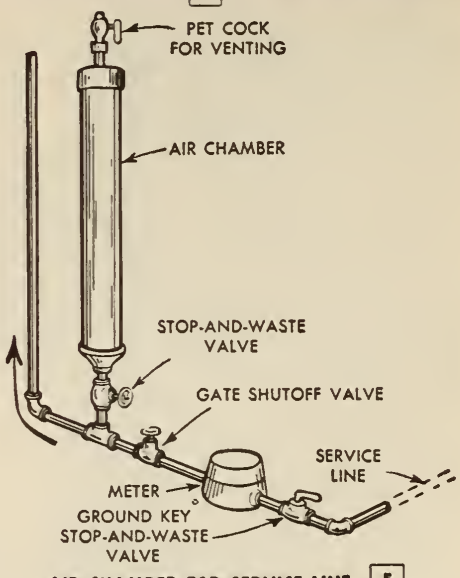
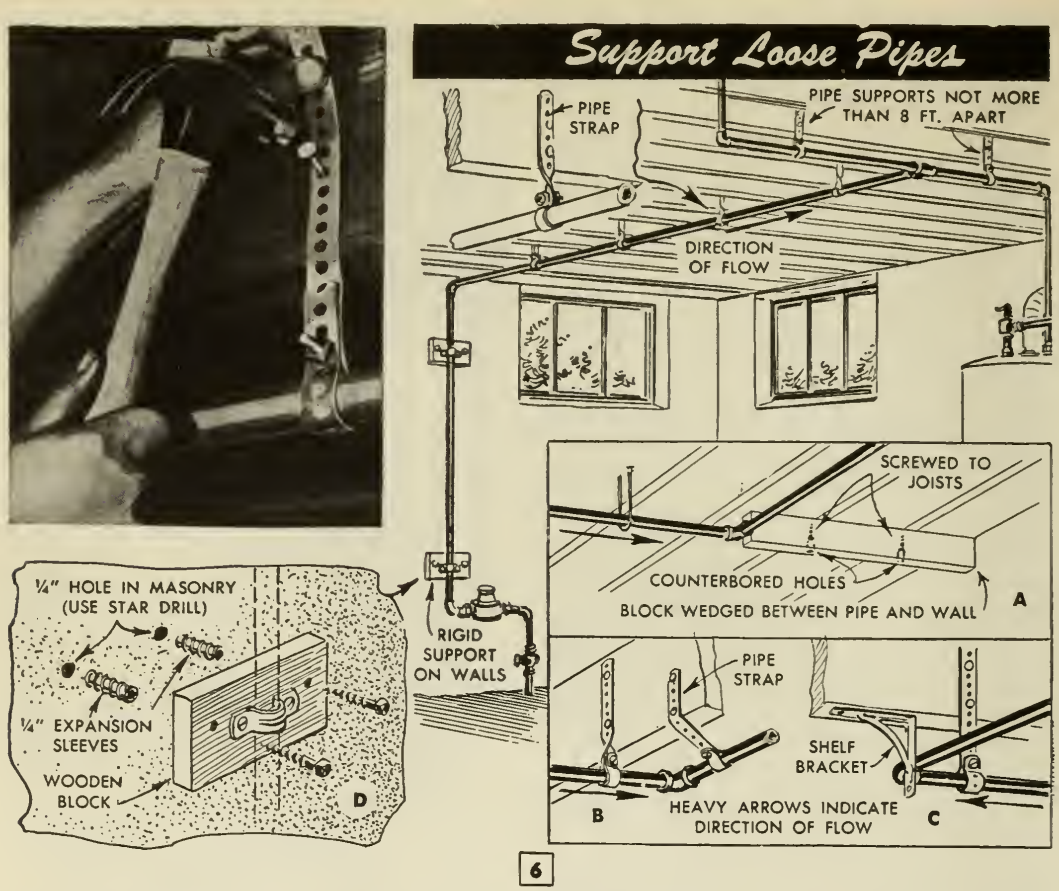


AIR CHAMBER FOR SERVICE LINE 5

Water-heater noises also can be traced to faulty pipe arrangements or pipe of insufficient size as, for instance, when an upper connection the shape of an inverted U retards circulation. To a lesser extent, the same condition occurs in an L connection—the lower line may become clogged and will then impede circulation. All of these connections allow hot water to be forced into the tank in spurts when pressure is built up behind it. Usually water-heater noises are easy to avoid if unimpeded circulation of water is assured by proper connections, adequate pipe size and clean, internal surfaces in the heating coils and pipes. Also, the provision of an air chamber or shock absorber in the line from a water-heating coil to a storage tank will generally reduce the noise.

Water-closet noises: Many water closets emit a high-pitched noise that sometimes becomes a whistle when a flush tank is being filled. This originates at restricted passages in a float valve, particularly with



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cheaper-type valves. Sometimes the condition can be remedied by proper adjustment of the valve. If not, the valve should be replaced with one that is more silent. If a float valve is provided with a backflow preventer or vacuum breaker, this sometimes causes a clicking sound. A low humming noise often indicates that water is running into the bowl after the tank has been filled, likely due to a leaky discharge valve. Usually the cause is a worn stopper ball but sometimes the seat is covered with grit or is pitted from corrosion. A new ball is the prescribed remedy, but the seat may also need cleaning and smoothing with emery cloth. More information on water-closet valves is given in *Valves and Faucets.*

High-velocity noises in pipes: Whistling noises often are caused by high velocity of water flowing through pipes. The noise is produced when water flows around bends at high speed, the pressure at the inside of the turn being reduced by centrifugal force. The smaller the pipe is, the faster the water flows when submitted to the same pressure as in a larger pipe. Thus smaller pipes cause more noise than larger ones. Often the noise can be reduced or eliminated by simply wrapping the pipe, if accessible, with several layers of hair felt, other sound-proofing material or by replacing the pipe with one of larger size. Floors and walls often act as sounding boards that intensify such noises. For this reason direct contact with a plastered wall, floor or joists under floors should be avoided.

Leaky faucets and water closets: Fig. 7 gives the cost of water leaks, which shows that it pays to prevent them. Leaks at faucets may be caused by a loose cap nut, worn packing in the nut, by a worn washer or washer seat. Methods of repair are given in *Faucets.* Water closets may develop leaks where the bowl connects to the soil pipe, usually indicated by water on the floor around this connection. The remedy consists of removing the bowl and resealing the joint as described in *Drainage.* Leaks may also occur between the tank and the bowl. They may be at the gasket between the tank and bowl if these are close-coupled or at the slip-joint elbow or sleeve between tank and bowl. Usually a new washer or gasket will cure the trouble. Another point where leakage may develop is at the joint between the float-valve stem and the tank, or at the point where it connects to the water-supply pipe. Assembly of the valve stem with the tank and pipe is shown in Fig. 15 of *Faucets.*

SIZE OF LEAK	CU. FT. PER DAY	COST PER YEAR AT $2.16	RATE PER 100 CU. FT.
..... STEADY DROP	3		
• 1/64	6	$4.32 1st 10 M CU. FT.	18c
• 1/32	23	2nd 40 M CU. FT.	12c
		$15.12 OVER 50 M CU. FT.	9c
● 1/16	93	$60.48	
● 1/8	400	$196.80	

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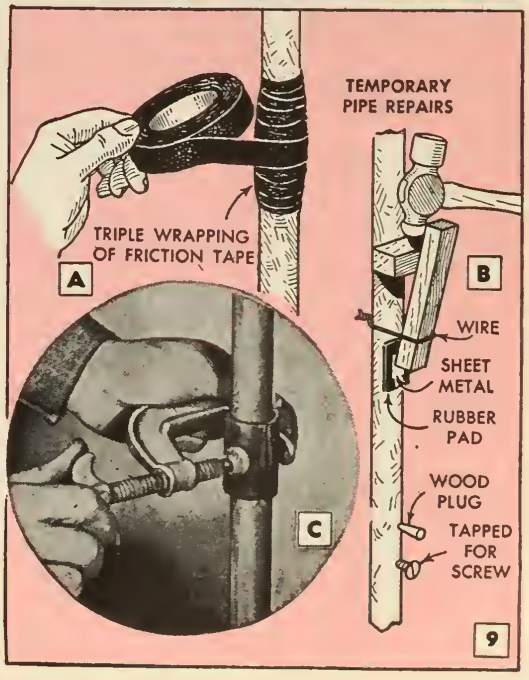
Pipe leaks: When leaks develop at the threaded joints of pipe, the joint is either loose or the pipe may be fractured. Slightly loose joints often become sealed by scale and rust formation. If the leak persists and is located within a reasonable distance from a union, or from the end of a pipe, it can be unscrewed and examined. Sometimes reassembling it after the threads have been coated with pipe-joint compound will make it leakproof. However, the threads on a pipe or those of a fitting may be defective or the fitting may be cracked and require replacement. Fractures from strain on pipes usually occur at the ends where the wall thickness has been reduced and weakened by threading, especially where threads have not been cut true. Strain on pipes may be caused by constant vibration or water hammer. Another cause of pipe leaks is freezing. Soft copper tubing can be subjected to repeated strains of freezing, enlarging each time, until it hardens and breaks. Flexible plastic pipe is not ruptured by freezing.

To repair a leaky pipe temporarily, you first shut off the water supply, then cut the pipe with a hacksaw on either side of the leak, after which a length of rubber hose or flexible plastic tubing is slipped over the ends as shown in Fig. 8, using hose clamps to tighten it securely. The inside diameter of the hose or tubing must be equal to the outside diameter of the pipe; 1-in. auto hose fits ¾-in. pipe and ¾-in. garden hose fits ½-in. pipe.

Other emergency repairs for leaky pipes are shown in details A, B and C of Fig. 9. Electrician's friction tape may be wrapped tightly around the pipe to 2 in. beyond the leak. The pressure may force water to leak between the pipe and the wrapping, but a slight drip is better than a spray.

The best repair is a permanent one made with pipe as in Figs. 10 and 11. Cut the pipe with a hacksaw to permit unscrewing it, unless a union is located nearby. Saw the pipe not less than 4 in. from a fitting as in detail A of Fig. 11. Then unscrew the cut ends. The new section is made up of two lengths of pipe and a union, which, when assembled, should equal the length of the old pipe. A single length can be installed only when the old length was disconnected at a union as shown in detail B. Sim-



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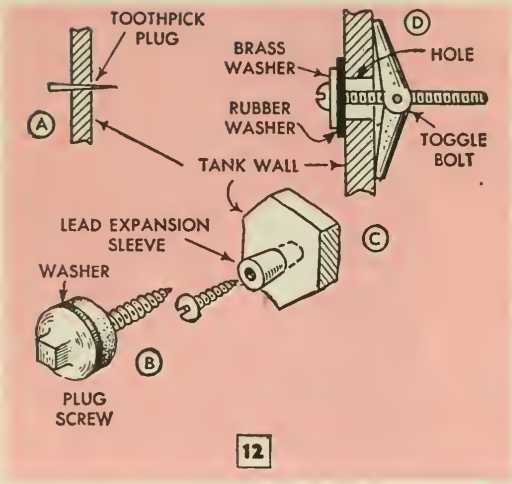

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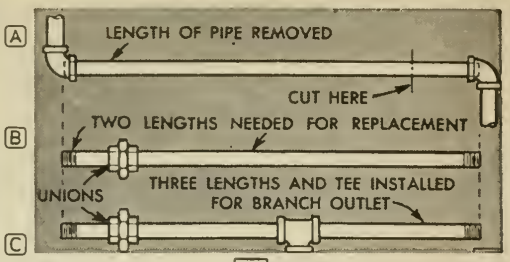
ilar procedure is followed when it is desired to cut a branch line into an existing line as in detail C, except that a T-fitting is required between two new pipe lengths, which when assembled should equal the length of the cut pipe.

When a pipe leaks inside of a partition or under a floor, it is generally necessary to remove plaster or a portion of the floor (or ceiling below) to get at the pipe. In some cases a repair can be made by uncovering the leaky pipe at two accessible points near fittings. The pipe then is cut near the fittings, the stub ends are moved and adaptors are used for connecting copper tubing of proper size. Being flexible, copper tubing can often be installed inside partitions and floors through two small openings with the aid of a chain. The old, leaky pipe is left in the partition or under the floor. Plastic pipe can be used instead of copper pipe if it is completely protected from rodents. Some kinds of plastic pipe in exposed locations are subject to rodent attack.

Leaks in tanks: Leaks in a hot-water tank



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generally indicate that the inside is badly corroded and weakened, in which case the tank should be replaced. However, an old tank sometimes can be kept in service until a new one is installed by making any of the temporary repairs shown in Fig. 12. If the tank is insulated, the outer covering and the insulation are removed to find and repair the leak. A pin-size leak often can be plugged by driving in the end of a round toothpick as in detail A. Swelling of the wood from its absorption of moisture will keep it in place. Larger leaks may be stopped by driving in a plug screw as in detail B. Another repair consists of drilling or reaming a hole to ¼-in. size to admit a tapered lead expansion plug as in detail C. Driving a screw through the plug expands it. Still another repair method, detail D, is to enlarge the leak enough to permit inserting a toggle bolt to hold a brass-and-rubber washer assembly snugly against the leak on the outside of the tank.

Dripping from condensation: In many localities trouble is experienced from "sweating" pipes—condensation of moisture on the outside. The beads of moisture collect and drop off and may damage tools or other articles underneath such pipes. Normally, water inside a pipe or container warms up to room temperature, at which point condensation on the outside stops. In a plumbing system, cold-water pipes remain cold because water is continually drawn from them so that condensation continues. When this occurs between walls and floors, considerable damage may result to wallpaper and plaster as well as to structural members such as sills and studs, which may deteriorate from rot.

In basements, condensation troubles usually are experienced during the summer months. In closed basements, humidity can be minimized by means of a calcium-chloride drier, Fig. 13, or an electrically operated dehumidifier, Fig. 14. Besides preventing pipes from sweating such control also prevents condensation on cool floors and walls.

Condensation on cold-water pipes can be prevented by covering them with antidrip insulation, which is available in various forms. The pipes can be wrapped with a

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thick tape containing ground cork as in Fig. 15, or coated with a thick plastic paint that contains cork granules, Fig. 16. Other coverings are tubular and split lengthwise for quick, easy attachment as shown in Fig. 19. These coverings may be air-cell asbestos, mineral or other wool. They are provided with a waterproof inner liner. Such insulation can be applied to exposed pipe, but hardly to pipe inside of partitions and floors without involving considerable cost and trouble unless installed when a house is being built.

Where much condensation forms on a water-closet tank and it drips on the floor, a tray like that in Fig. 17 can be attached under the tank. Trays on wall-hung tanks have a drain tube leading to the bowl; those on close-coupled tanks are provided with absorbent pads. Some tanks are made with an inner liner, such as shown in Fig. 18, which prevents them from being cooled by the water inside and thus prevents sweating. A water-tempering tank, which should never be insulated, can be provided with a drip pan if moisture on the basement floor is objectionable.

Protecting water pipes from frost: Where water pipes are exposed to low temperatures, they should be protected with insulation of suitable thickness; 1¼-in. felt covering generally is used. The covering must be continuous without any air gaps between adjoining lengths and must be carried over all pipe fittings. The pipe is first wrapped with tar paper, then covered with insulation which is wrapped with canvas as shown in Fig. 20A. Various types of tubular insulation can also be used, in which case the joints also are covered.

Installed pipe that will be exposed to weather must be properly protected. Where pipe is already installed, it may be enclosed with a water-tight wooden box, shown in Fig. 20B, in which case the space between the pipe and box is packed with sawdust, ground cork, mineral or other wool. The insulation between the pipe and the box

General Motors Corp., Frigidaire Div. photo

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should not be less than 2 in. thick and it must be kept dry. A covering of roofing paper can be nailed over the box for this purpose. Sawdust makes good insulation but provides a good refuge for termites. It also settles after a while and more sawdust must be added occasionally to maintain its original thickness. Asphalt-impregnated fiber pipe, clay pipe, asbestos-cement and cement pipe can be used as an outside covering over insulation. An example of how an outside riser can be so protected is shown in Fig. 21. Underground piping should be laid below prevailing frost penetration. If this is not possible it should be covered with insulation protected against moisture.

Thawing frozen water pipes: Where electricity is available, the simplest method of thawing out a frozen pipe is by means of a pipe-thawing transformer such as used by many plumbers. While this method is quick, clean and relatively inexpensive, it is also hazardous if improperly done by novices. The clamps at the ends of two heavy cables are attached to the pipe on either side of the frozen section as shown in Fig. 22. An electric current flowing through the pipe between the clamps heats the pipe and melts the ice.

If such a pipe-thawing service is not available, and the frozen section of pipe is accessible, you can apply heat externally by holding an electric iron against the pipe or by placing an electric heater near it. However, when thawing a pipe by subjecting it to heat, never start at the middle of the

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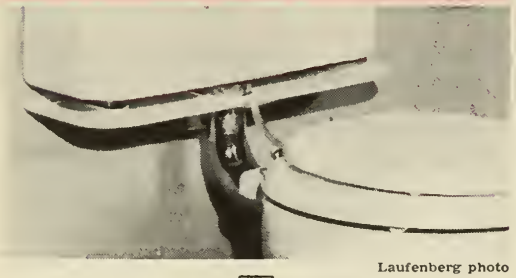

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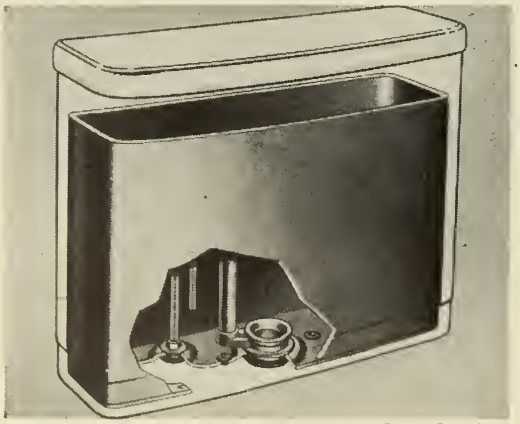

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frozen section since the expansion of heated water confined by ice, or possibly the formation of steam, may burst the pipe. Start thawing on the faucet side of the obstruction and work toward the supply, keeping the faucet open so that you will know when the ice has melted. Be ready, however, to turn off the water supply in case the pipe has been ruptured.

Heat can also be applied in other ways. About the simplest method is to wrap the pipe with twisted rags or burlap to obtain a suitable thickness, and then keep the wrapping saturated with boiling water, as in Fig. 23. A blowtorch will give quick results where the pipe is accessible and not close to wood, paper or other combustible material. A sheet of asbestos board also can be used as a protective shield. Another method is to run boiling water inside the pipe if part of the pipe can be removed as in Fig. 24, or if you can start working from an outlet. For horizontal pipes you run the boiling water through a small pipe so that it flows against the ice, and the cooled water drains off into a pail. In vertical lengths of pipe you can use a rubber tube in the same way, keeping its end against the ice. A jet of steam works still faster.

Scale and corrosion: Scale and corrosion on the inside of water pipes generally cause most damage to plumbing systems, since the pipes may become completely clogged. The rate at which scale and corrosion form varies with the chemical properties of the water and also its temperature. Scale forms faster on the rough surface of galvanized-iron pipe than it does on the smooth surface of brass pipe and copper tubing. It also forms faster wherever there is resistance to the flow of water as at elbows, tees and other fittings. Hard water causing scale formation can be recognized as such by its inability to form suds and lather easily. When hard water is artificially softened, the calcium and magnesium compounds which make it hard are removed.

Hard water is not as corrosive as natural soft water containing free carbon dioxide. A 40-deg. temperature rise in water about doubles its corrosive action and also hastens scale formation. Therefore, the life of hot-water pipes is considerably less than that of cold-water pipes. Rust "grows" to more than 10 times the volume of the iron from which it forms and this alone clogs pipes. Enough rust often is released in pipes to discolor the water and stain fabrics. Corrosiveness of water can be reduced considerably by removing the carbon-dioxide gas.

Clogged pipes and heater coils: When the flow of water from faucets becomes much less than it was when the pipes were new, the inside is probably caked with scale and

corrosion. Replacement of the fittings alone may restore a satisfactory water flow for some time if the pipes themselves are not heavily coated. If badly caked, they should be replaced. Copper pipe and tubing are less subject to corrosion than iron and steel pipe; plastic pipe is not affected by corrosion but cannot be used for hot-water lines.

When it takes a long time for water to heat, the trouble may be caused by scale and corrosion accumulations in a heating coil or furnace water back in the pipes connecting these coils to hot-water tanks. The scale acts as insulation, preventing maximum heat transfer and consequently much time and heat are required to heat the water. As soon as such sluggish results are noticed in a coil water heater or water back, remove and inspect it. Generally badly caked coils and water backs must be replaced; although if the scale is caused by limestone, it can be softened and removed by using a muriatic-acid solution. This consists of muriatic acid, 1 part, slowly added and stirred into water, 4 to 7 parts, depending on the thickness of the scale. The mixing of the solution is done in a glass or porcelain container. Be careful not to get the acid on the skin or clothes as it causes burns and is corrosive and poisonous. To use the solution, close the lower opening of the coil, pour the solution into it and let it stand for a period of 4 to 6 hrs. Then pour out the solution and flush the coil with water to remove all traces of the acid. If one treatment does not remove the deposit, repeat as many times as is necessary. Deposits other than limestone, as for instance gypsum, are not appreciably affected by this solution. When a limestone-caked pipe is located in a wall or other place where it cannot be removed easily for replacement without considerable damage, the acid treatment can be tried.

Frost precautions in closed house: When a house is closed during cold weather and is not heated, the water system must be drained completely to prevent damage from freezing. First shut off the water supply at the main control valve near the meter, and turn off the heat source of the water heater. Then open the drain valve at the lowest point of the piping and also open all faucets so that water will flow out more easily. Also open the drain faucet on the water heater, and if it has a heat trap, water must be removed from this also. For this reason a drain valve should be provided at the lower point of the trap. Empty water-closet tanks by flushing. If the system includes water-softening or conditioning equipment, or any tanks for water storage, these too must be emptied completely. It also is advisable to have the water service turned off at the curb valve and to have the water

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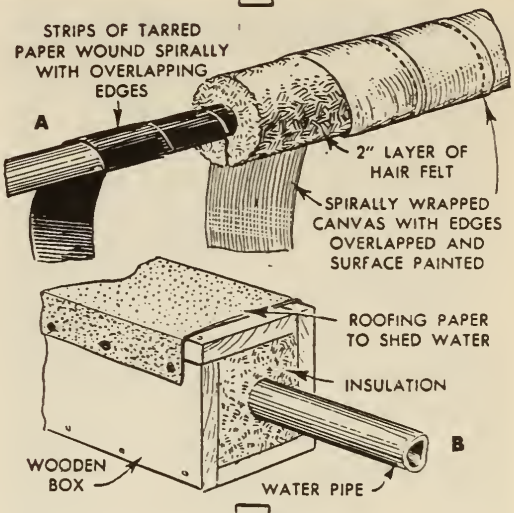

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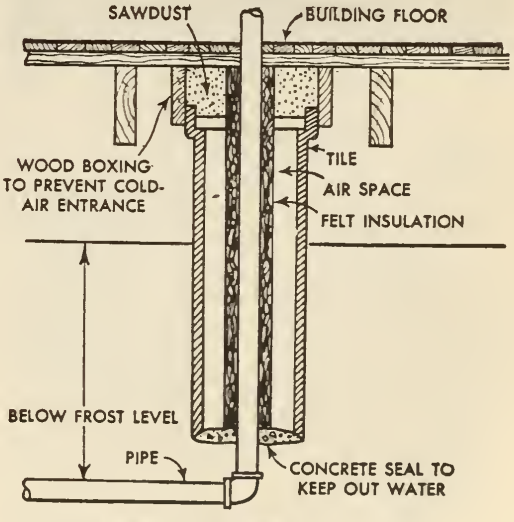
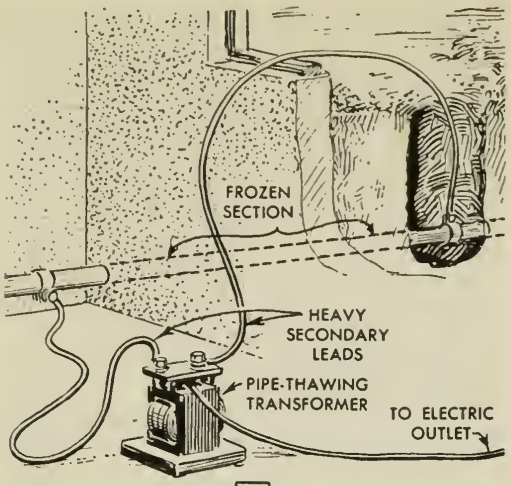


21 FROST PROTECTION FOR A COLD-WATER RISER BETWEEN GROUND AND FLOOR

Tennessee Valley Authority illustration



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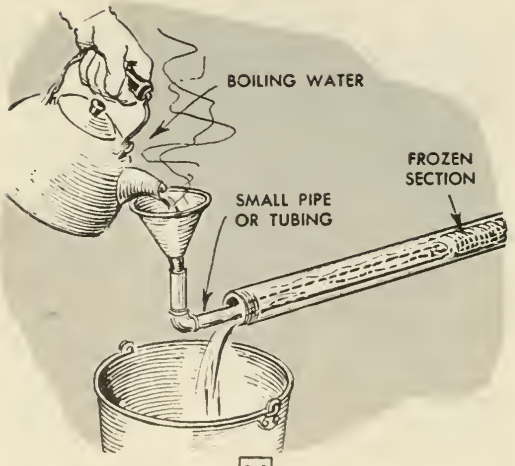

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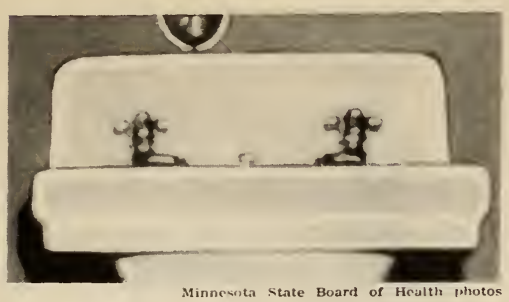
meter removed. If this is not done the exposed part of the service pipe and meter should be carefully insulated to prevent water inside from freezing. Water in heating systems and traps of the drainage system, including water-closet traps, must be removed also. Kerosene is substituted for water in traps.

Water-pressure troubles: One of the most common complaints of home water supplies is variation of water pressure; for example, a running mixture of hot and cold water at a shower or bath suddenly varies in volume of flow and temperature due to drawing water from another outlet. Such variations often are enough to cause discomforts and may even result in injury when the water mixture becomes scalding. Where such trouble is constant and frequent, the water pipes may be too small—either of inadequate diameter for their length and height as originally installed, or their diameter may have been reduced by liming and corrosion. Another cause of inadequate pressure and water flow is excessive friction in the pipe due to too many fittings and changes of direction. Or, piping originally adequate may have become overloaded by an extra bathroom or automatic washing equipment.

When variations of pressure at shower and bath outlets only occur when other outlets are opened, the situation can be remedied usually by installing automatic mixing valves. This, however, does not increase the maximum water flow from an inadequately sized pipe, which can be done only by replacing the pipe with one of larger size. Replacement of pipe also becomes necessary where water pressure is inadequate at outlets but is sufficient at the service-line entrance.

Temporary low pressure can be occasioned by large amounts of water being drawn off the city mains in the neighborhood, as for instance by fire equipment, but this trouble is only temporary. A pressure gauge at the meter location will show whether continued low pressure at outlets is caused by pipe resistance inside of the house or whether the fault lies outside. It can be occasioned by a service pipe that is clogged or is of too small diameter. This is likely to be the case if the pressure at the curb valve is much higher than that at the house entrance of the service pipe. A clogged service pipe can be cleared by using a drain auger (new or sterilized). When pressure at the curb valve is not much higher than that of the house end of the service line, the fault may be an obstruction between the curb valve and the city water main, or the pressure of the latter may be insufficient. Where water pressures are too high, which may cause water hammer and



Minnesota State Board of Health photos

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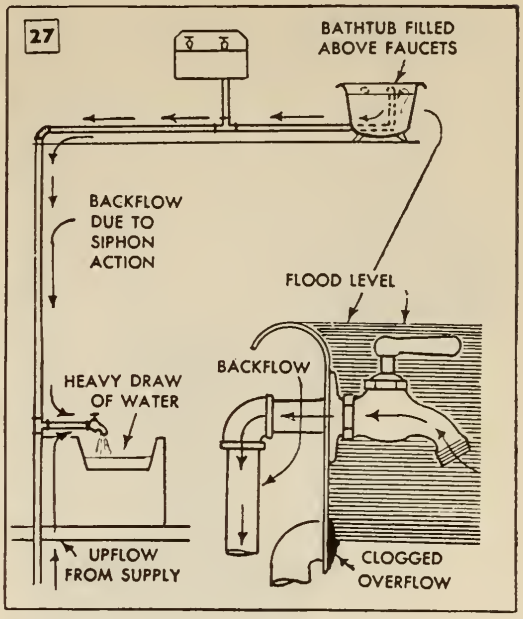


whistling noises, the pressure can be reduced by using a pressure-reducing valve. Where water pressures are too low in water lines, a condition may be created where backflow from fixtures is experienced, as described below.

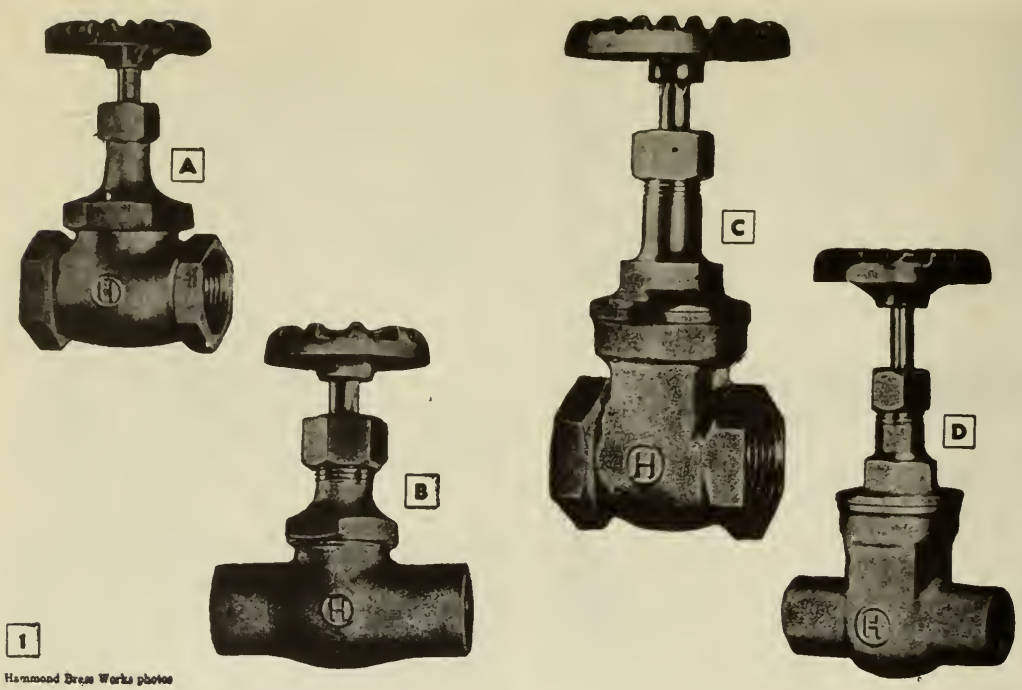
Hazards of cross connections and backflow: Polluted water from a drainage system may get into the water-supply lines under certain conditions. This has caused numerous epidemics such as the amoebic dysentery in Chicago during 1933. Amoebic dysentery is most common in warm or tropical countries, but it may break out in cooler climates as evidenced by the Chicago epidemic. Germs causing typhoid fever and other diseases, once inside the water pipes, can spread to all parts of the system. Chlorinated water used in many cities kills all known waterborne germs except the one causing amoebic dysentery; this one is able to survive about 15 days in chlorinated water. The disease can sometimes be cured by the use of drugs, but prevention is the best cure.

When a water-supply outlet is located below the flood-level rim of a fixture, the outlet will be submerged when the fixture is filled. Then a cross connection exists between the drainage and the water-supply lines. This is especially likely to occur with obsolete fixtures such as shown in Figs. 25 and 26. When a water-supply outlet is submerged, the contents of drainage lines can be sucked into the water line. This happens when pressure in the water line is decreased below atmospheric pressure and may be occasioned when a large quantity of water is drawn off at a lower point in the house as illustrated in Fig. 27. The polluted water can even seep through a closed faucet if it is leaky, or it can be drawn up through a spray nozzle submerged in a bathtub or kitchen sink. This reverse flow is called back-siphonage or backflow. It is especially likely to occur when a lower water-supply branch is much larger than necessary. It can also be caused by a broken water main or a heavy draw from the water main by fire apparatus. Draining water from a basement or first-floor outlet while the main supply line is shut off causes backflow from points above.

Backflow is particularly common in downfeed water systems—those having an overhead supply tank from which water flows down to fixtures. It can occur also in any upfeed system—water supplied from city main or pressure tank below fixtures.

Preventing cross connections: Cross connections and backflow can be eliminated as follows: (1) by providing a suitable air gap between the outlet and the flood-level rim of a fixture (where this is impossible an approved type of backflow preventer or vacuum breaker should be used), and (2) by assuring a positive water pressure at all outlets at all times.

Air gaps should not be less than 1 in. for a lavatory, 1½ in. for a kitchen sink or laundry tub, and 2 in. for a bathtub. If outlets are closer to a vertical wall than twice these distances, the normal air gap in each case should be increased 50 percent. Old fixtures often can be altered to meet these requirements.



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Hammond Brass Works photos

Valves and Faucets

CONTROL OF WATER SUPPLY is the function of valves and faucets, which also are referred to as cocks, bibbs, stops and taps. Valves and sill cocks are used on pipe lines; faucets are installed at fixtures. Having a sufficient number of valves in a water system enables you to shut off any branch individually instead of the entire system. Being able to do so quickly may prevent flooding and costly repairs. Valves in home plumbing lines usually are cast bronze and have portions machined and threaded for trimmings. See details A and C of Fig. 1. The port ends (ends that connect to lines) may be tapped for screwing to pipe or may be smooth for soldered joints to tubing as in details B and D. Since valves are of different types for specific purposes, they should be installed accordingly.

Gate valves: A gate valve, of which a cross-sectional view is shown in Fig. 2, has a sliding wedge that is moved across the waterway, usually by means of a threaded spindle or stem. This may be the rising or the nonrising type; the latter type has the shorter bonnet. A gate valve is primarily used to completely shut off or completely open a waterway, but not to control the volume of flow. Either port (opening) of a gate valve may face the pressure side of the line. The chief advantage of a gate valve is that it permits complete passage of water without adding appreciable resistance to the flow. Therefore gate valves should be used on all supply lines that are in constant use, particularly where water pressure is low.

The sliding wedge or gate may be either solid or split, as in details A and B of Fig. 3. One part of a split wedge pivots on a rounded seat on the other so that they automatically adjust themselves to the angle of the double seat. The seat may be part of the body casting ground to a smooth surface, or it may have inserted corrosion-resistant rings. The waterway through the seat corresponds in size to the size of pipe on which the valve fits. Often the bonnet that holds the spindle in place is attached to the body with a union ring. The spindle may be either the stationary or the traveling type. When leakage develops between disk and seat, it is generally necessary to replace the valve because it is difficult to reface the seat, although new disks may be installed.

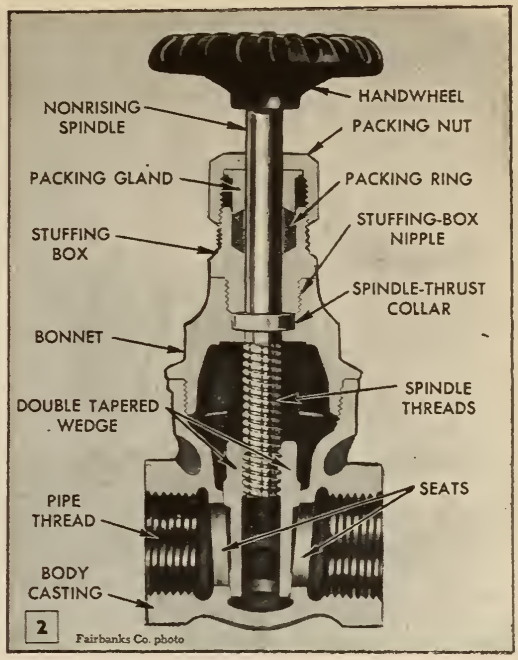
Globe and angle valves: Wherever a valve must be opened and closed frequently, and water pressure is sufficiently high, a globe valve, Fig. 4, is customarily used in spite of the added resistance it introduces

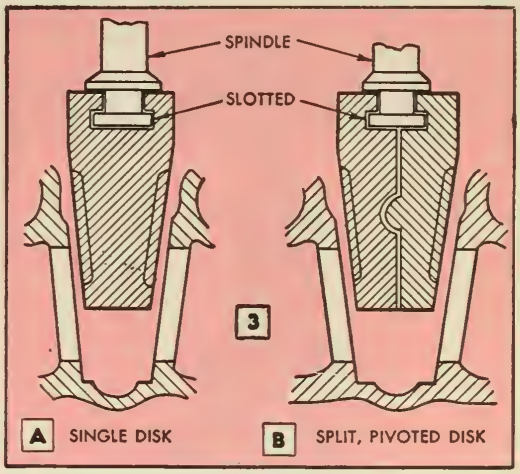
into the line. Globe valves also are generally used to control volume of flow. A globe valve has two chambers. The partition between them is drilled for the passage of water, which must change its course several times from port to port, Fig. 5A, introducing resistance. Therefore, globe valves generally should not be used in water-supply lines to serve occasional shut-off purposes only. To close a globe valve, a disk, usually faced with a composition washer, is brought down on the seat by turning the spindle. The ground seat may be flat or beveled as in detail B of Fig. 5.

Often globe valves are installed so that the water pressure is exerted under the disk. When so installed, spindle packing can be replaced while the valve is closed—or when fully opened if it has a back seat that prevents leakage of water past the spindle. When a globe valve having no back seat is installed so that water pressure is exerted downward, the supply line must be shut off for packing the stem. However, downward pressure on the disk minimizes trouble from leakage, tends to keep the valve closed when not tightly shut off by hand, and in case of failure of threads on the spindle, the valve will close automatically instead of "blowing open." When a globe valve is installed on horizontal pipe so that the handle sets vertically either above or below the valve, water will not drain out of the line completely, as indicated in detail C. To avoid this trouble, arrange the spindle horizontally so that water can pass through the seat opening as in detail D.

An angle valve is similar to a globe valve but has its ports at right angles, Fig. 6. Usually the water passage is larger than it is on a globe valve, and since there is only one change of direction of flow, less resistance is introduced. An angle valve installed at a turn in piping eliminates the need of an elbow, and often is preferable to using a globe valve and an elbow.

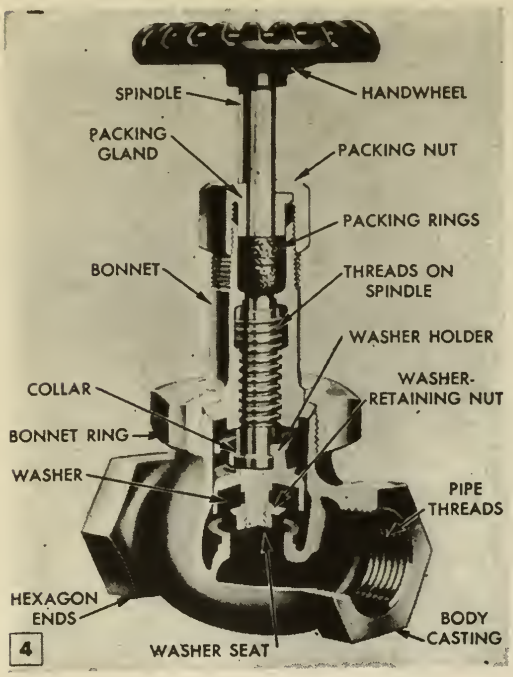
Reconditioning globe and angle valves: Most globe and angle valves have a composition washer which should be replaced at the first sign of leakage. After removing the spindle assembly, loosen the screw or nut holding the washer. Remove the washer and carefully scrape away all traces of it that may have stuck to the disk, Fig. 7. The new washer, held either by a screw or nut, should be tightened in place securely. If a nut is used to hold the washer, it is prick-punched to lock it on the projecting threaded end. For valves on hot-water lines, use only the hard or semihard washers. The semihard washers are also used on cold-water lines, but the soft, resilient type is preferable. Washers come in various diameters and should be selected to fit the washer holder accurately.





When a new washer does not produce a tight seal, the valve seat requires dressing. Some globe valves have renewable seat inserts. To dress the seat of a small globe or angle valve, you use a standard reseating tool of the kind shown in Fig. 26, which also is used for reseating compression faucets. Use very slight pressure on the reseating tool and remove only as much metal as is necessary to obtain a smooth seat. When finished, remove the chips before reassembling. If a valve seat has been weakened by repeated dressing, or is damaged beyond repair, a seat insert, Fig. 27, is less expensive than replacing the valve. However, as the insert restricts the opening, it should be used only if water pressure is adequate.

Globe and angle valves not fitted with composition washers, but having a metal-



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ANGLE VALVE
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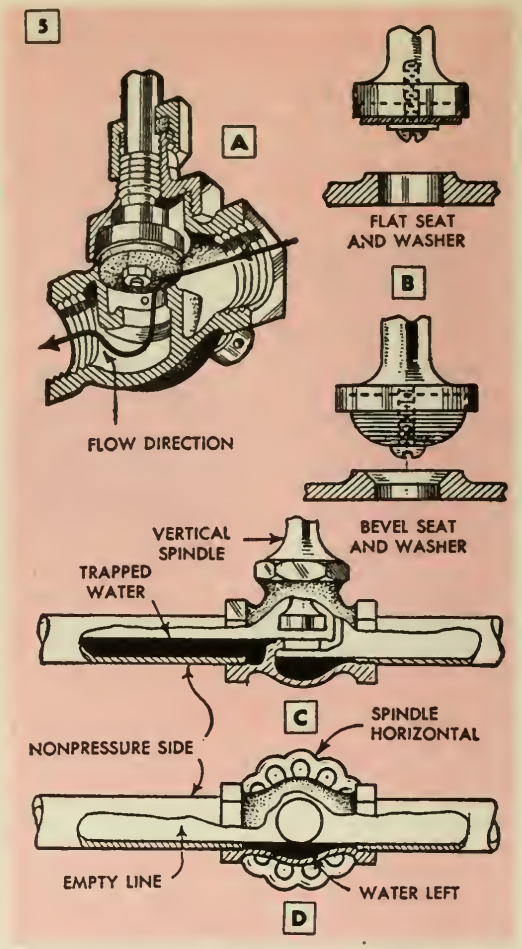

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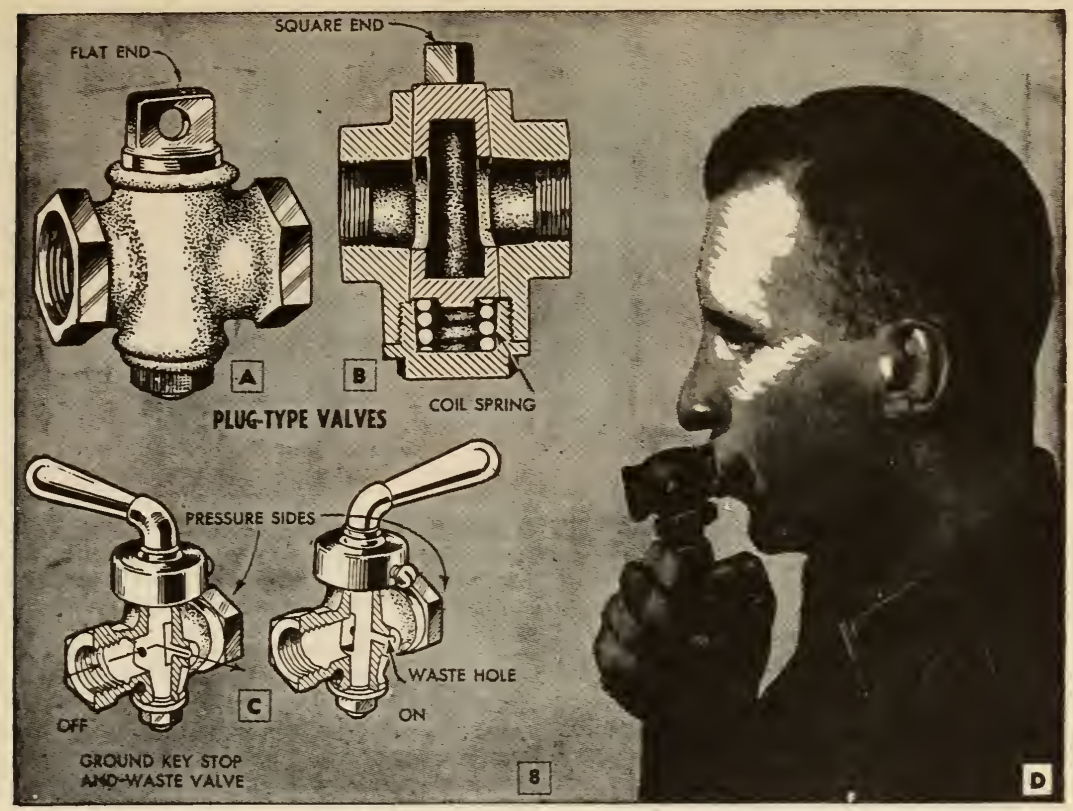
to-metal seat contact, are sometimes preferred for hot-water lines. Leaky seats of this kind must be reground. Some valves have provision for locking the disk to the spindle, such as a grooved locknut and a small hole in the spindle for a holding pin, permitting the spindle to be used as a grinding tool. After locking the disk to the spindle and putting a moderate amount of grinding compound between disk and seat, screw down the union ring tightly with the fingers but then back it up exactly one full turn to keep the spindle perfectly vertical. More than this would allow the spindle to be tilted while grinding. To grind, turn the spindle back and forth not more than a quarter turn, a number of times at different points of contact between disk and seat. Do not overgrind. Clean out the grinding compound thoroughly before reassembling.

Plug or key valves: These, shown in Fig. 8, have a tapered, ground plug fitting a mating tapered hole or seat. An opening through the plug provides an unobstructed waterway producing minimum resistance to flow. In this respect, it is comparable to a gate valve. A quarter turn opens and closes the valve. The common type shown

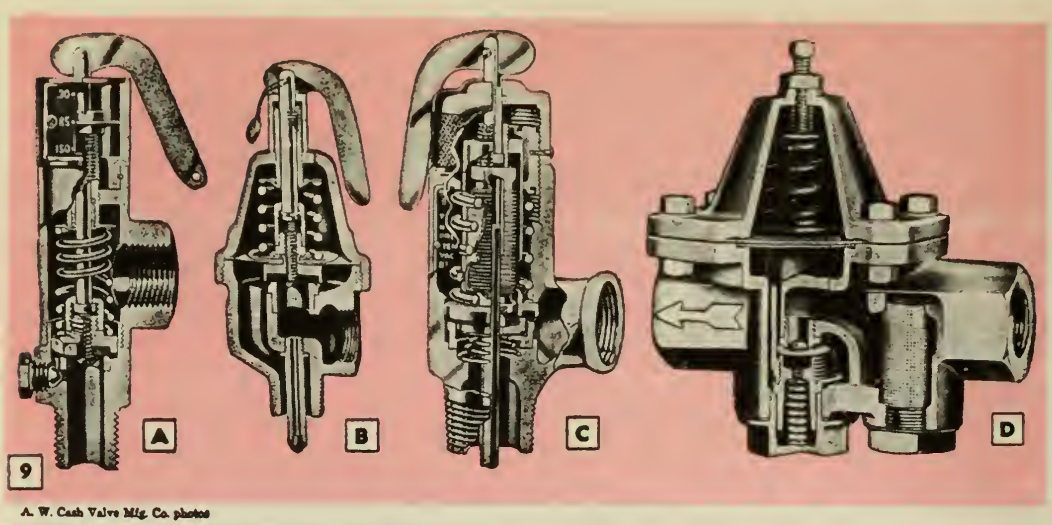


in detail A has both ends of the plug extending outside of the body. The large end may be flat, or square so as to take a small wrench, or it may be provided with a handle as in detail C. The small end usually is threaded for a nut which holds the plug snugly in its seat. On the type shown in detail B the arrangement is reversed; the small end is the handle end and the large end is placed under pressure of a coil spring. This type generally causes less leakage. Because of the spring there is less danger of distorting the plug in case the water is frozen.

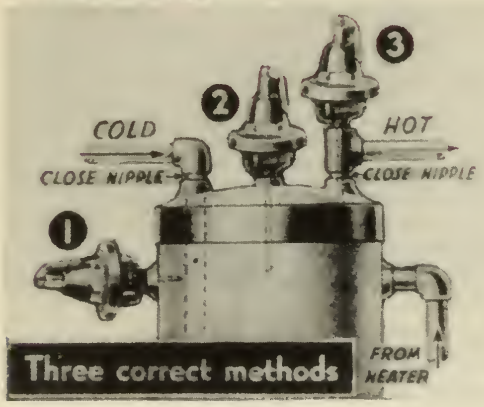
In a plug valve, sand or grit in the water is likely to jam or scratch the ground surfaces, resulting in leakage. Therefore, these valves are not durable when subjected to constant use, but are very serviceable for occasional shut-off purposes. They often are required by code as a main shut-off valve on the street side of a meter, in which case they should be of the drainable type. The same kind also may be used on lines supplying sill cocks where globe valves introduce too much resistance to flow. Curb stops are usually of this type also. When leaky, such valves must be replaced as a rule. Sometimes it is possible to recondition them by using valve-grinding compound, but it is difficult to restore the original mating surfaces.

Drainable valves: Valves, which are provided with a small drain outlet in the body to allow water in the nonpressure side of the line to be drained out when the valve is closed, are called drainable or stop-and-waste valves. Gate, globe and plug valves can be of this type. Detail C of Fig. 8 shows a drainable plug valve. To determine which port should face the line pressure, you blow into both ports as shown in detail D while the valve is closed and the drain outlet is open. The port through which air flows is the one to connect to the line requiring drainage.

Installing valves: Be sure to cut pipe threads to the correct length (so the pipe end comes to the edge of the die). If the threaded end is too long, the pipe can be forced against the diaphragm or seat of a valve, which may distort it. Avoid excess pipe dope and don't put it on the internal threads of a valve. Support pipe adequately to prevent strain on valves, especially small ones. Before installing a valve be sure that the pipe has been cleaned thoroughly of chips caused by threading and reaming, and also of other foreign matter. This may lodge on the valve seat and cause trouble. Open the valve and clean it out thoroughly by flushing with water. After cleaning, close the valve and then install it. Use a flat-jaw wrench that fits the hexagon parts.



A. W. Cash Valve Mfg. Co. photos



Valve maintenance: A very slight leakage of water, especially hot water, across the seat of a valve wears tiny grooves in it. This is known as "wire-drawing" and eventually damages a valve beyond repair. When a valve cannot be closed tightly by hand, don't use a wrench or apply any other form of leverage to force it tighter as this may ruin it. Inspect valves periodically. When a valve is shut and water continues to trickle from an outlet under its control, the valve leaks. The remedy depends on its type and condition.

When water leaks from the stem or spindle, the packing must be replaced. To do this, loosen the packing nut, lift up the gland, remove the old packing and replace it Use graphited asbestos packing. The split-ring type of correct size is most convenient but a few turns of the stranded type of wicking also is effective. When replacing the packing nut don't turn it too tight; just tight enough so that the packing will stop leakage. Some valves have a "back seat" which allows them to be opened fully when repacking the stuffing box. Others require turning off the water.

Safety-relief valves for water heaters: A safety-relief valve on a hot-water tank opens to let out water at a predetermined pressure and temperature below the danger point. There are two basic types of relief valves: the pop-type valve, and the diaphragm-type valve. Both are shown in details A and B of Fig. 9. Both kinds are spring-loaded, and are either preset by the manufacturer to release at a certain pressure or are adjustable to various pressures like the one shown in detail A, which also has a visual pressure scale that can be turned to any convenient position. Both types of valves are obtainable with fusible plugs which melt at a temperature of 210 or 212 deg. F., allowing hot water to escape and cold water to enter the tank, until the water is shut off and another plug inserted. A fusible plug in the side of the valve, as shown in detail A, can be replaced without unscrewing the valve, which is necessary when replacing a plug fitted on the end of a stem as shown in detail B. The latter kind, however, are more critical. The need of replacing a fusible plug calls definite attention to a possible disorder.

Another type of relief valve, shown in detail C, is opened and closed automatically by either pressure or temperature. In addition to a spring-loaded pressure release, this type has a thermostatic bellows, to which a short or long stem is connected. It comes either with or without a test lever. Such valves with short stems are used for ordinary water heaters and those having long stems are recommended for electric heaters and insulated tanks.

A valve that relieves pressure only, and is not provided with a temperature-actuated relief feature, may stick and fail to function when necessary. It is also desirable to have a relief valve fitted with a test lever used occasionally to check the working condition of the valve. Selection of a re-

lief valve must be made so that it conforms to local code requirements. A relief valve should be installed at the point of maximum water temperature, not more than 3 in. from the tank. It is installed usually with a T-fitting at the hot-water connection to the tank but it may be located at other positions. See Fig. 10. No other valve should be placed between the relief valve and the tank. Relief valves are especially important on "closed" water systems — those fitted with check valves or pressure-reducing valves.

Pressure-reducing valves: Wherever water pressure exceeds 80 or 90 p.s.i., a pressure-reducing and regulating valve should be installed in the water line near the meter and in an accessible position. Its purpose is to minimize or eliminate "water hammer," which causes annoying noise and also subjects pipes, valves, faucets and even fixtures to severe strains which may damage them. Detail D of Fig. 9 shows a cutaway view of one type of pressure regulator designed for domestic use. Standard factory practice is to preset such valves to maintain a uniform outlet pressure of about 45 p.s.i., but other reduced pressure settings are available. Specifications necessary for selecting the right size of valve are maximum inlet pressure, required delivery pressure and capacity of the water system in gal. or cu. ft. per minute. Seats of these valves usually are renewable, and some types are provided with a strainer on the inlet side, which requires occasional cleaning. Wherever a pressure regulator is used it is essential to provide a pressure-relief valve on the low-pressure side of the line, as accomplished with a safety-relief valve on a water heater.

Check valves: Fig. 11 shows a solder-end, swing-type check valve and Fig. 12 shows the inside of a similar valve having pipe-thread ends. A check valve operates automatically, permitting flow in one direction only. Sometimes a check valve is combined with a throttling or shut-off valve. Some localities require a check valve in a cold-water line between the water heater and the meter. Also, check valves are used to prevent water pumped to an overhead tank from flowing back when the pump stops. Some check valves are designed for use on vertical pipes only; others are for horizontal pipes only. Therefore correct installation is essential. The closing device—disk, ball or clapper—should fall shut by gravity.

Swing-type check valves generally used in horizontal water-supply lines are installed so that the small projections on the outside of the body will be nearest the pressure side of the line; the cap that closes the body should face up. If a composition washer is used on the disk, it can be renewed

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Fairbanks Co. photos

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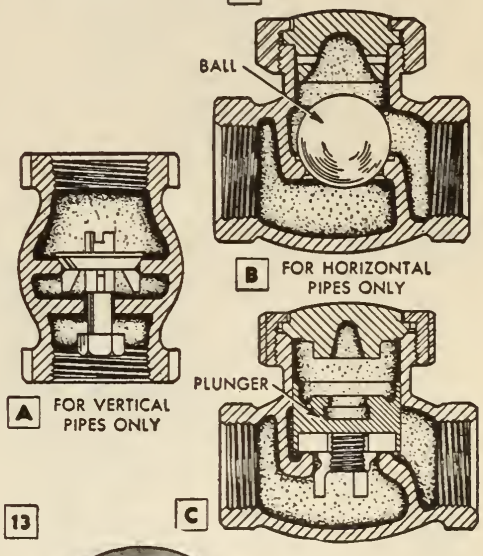

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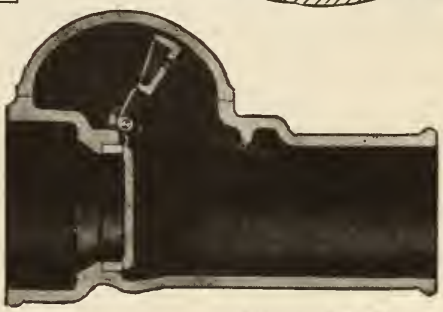

Kennedy Valve Mfg. Co. photo

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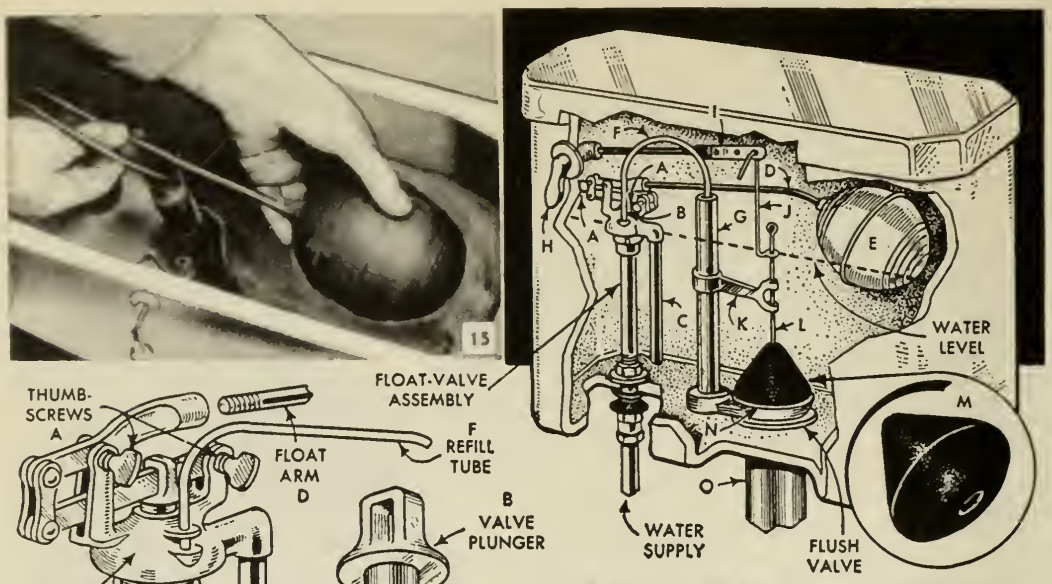
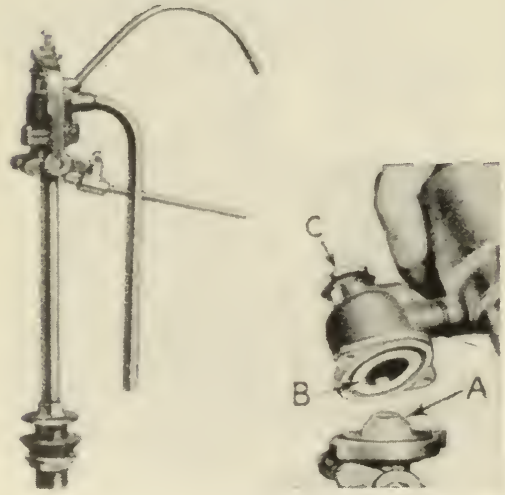


Above and at the left: A, pins or thumbscrews to release valve plunger; B, valve plunger; C, filler tube; D, float arm; E, float; F, refill tube; G, overflow pipe; H, trip-lever handle; I, trip lever to release rubber stopper; J and L, stopper wires; K, stopper guide; M, stopper; N, flush-valve seat; O, discharge pipe



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when leakage develops. On valves not so equipped it may be necessary to replace the valve. On lift-type check valves, details A, B and C of Fig. 13, the line pressure should be under the seat. When leaky, these valves can sometimes be reground like globe valves. Others require renewal of the disk and seat, or must be replaced entirely. Fig. 14 shows a swing-type check valve of much larger size—called a "backwater," or "backflow," valve. These are installed in house drains to prevent sewage from backing up into them. Information as to location and method of installation is contained in the section on *Drainage*.

Valves on tank-type water closets: Fig. 15 shows a water-closet flush tank which functions by means of two valves. One is a float-controlled valve (float valve) through which water enters. The other is the discharge valve. Different makes vary in detail but the operating principles are similar. When the float E is raised to a predetermined level, the valve closes. On some types an adjustment screw controls float height, which is preferable to bending float-arm D, necessary in other types. When water continues to run into overflow pipe G, the float valve is not fully closed or else it leaks. Reason for not closing may be that the float rubs against the tank wall or contains some water caused by pinhole leaks. Check the valve action by raising the float arm to shut it. If water still escapes, the valve is leaky.

The usual repair consists of renewing the washer on plunger B, which is removed by loosening thumbscrews A, after turning off the water supply. The washer may be different from the one illustrated, or it may be a disk held by a brass ring. Sometimes the valve seat can be refaced, using the same method as for faucets. If reconditioning the valve does not stop leakage, replace it. Float valves come in either short or long lengths. Sometimes the threaded tailpiece.

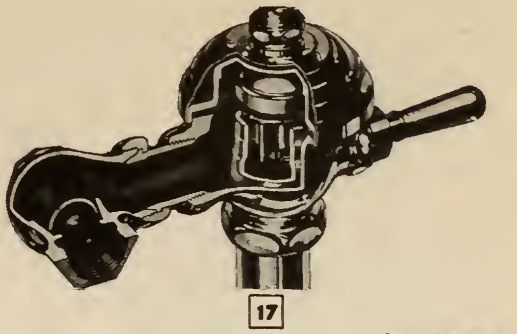
held in place on the tank bottom with locknuts and rubber washers, need not be removed if the supply pipe can be screwed into it. Filler tube C, also called the "hush tube," extends almost to the bottom of the tank so that the end will be submerged while refilling the tank. This reduces noise by eliminating splashing.

The water level in a tank should not extend above the float valve as this causes a cross connection. It is always best to have a float valve fitted with a backflow preventer or vacuum breaker. As little as 4 gal. of water will flush a bowl generally, but most tanks discharge more than this. Excess water serves no useful purpose and is merely wasted. If the water level is too high, adjust the float. Saving 2 or 3 qts. of water at each flushing means a considerable total in a year. The refill tube F empties into the overflow pipe G and supplies water to seal the bowl trap after flushing.

Leakage from tank to bowl through the discharge valve is quite frequent. This may be caused by grit on the plastic or rubber stopper M, by its being worn, by not seating properly, or by grit or corrosion on the stopper seat N. Improper seating may result if stopper guide K, clamped to overflow pipe G, is not concentric with the stopper seat. Wire L, which screws to a stopper, should project about 1 in. through the eye on the end of wire J, which connects to the trip lever I. If this alignment and the action of stopper seem to be correct, remove the stopper by unscrewing it from the wire, and clean the rounded surface. Also dry valve seat N and clean it with fine emery cloth. If the valve still continues to leak, substitute a new stopper. Usually stoppers require replacement every few years. If the valve seat is badly corroded, replace the seat and overflow unit.

The type of float valve shown in Fig. 16 is designed to give quiet action. Valve seat A is vitreous china, which resists the corrosive effects of water. Adjustment C controls flow at B for minimum noise.

Flush valves on water closets: Flush-valve operated water closets are connected



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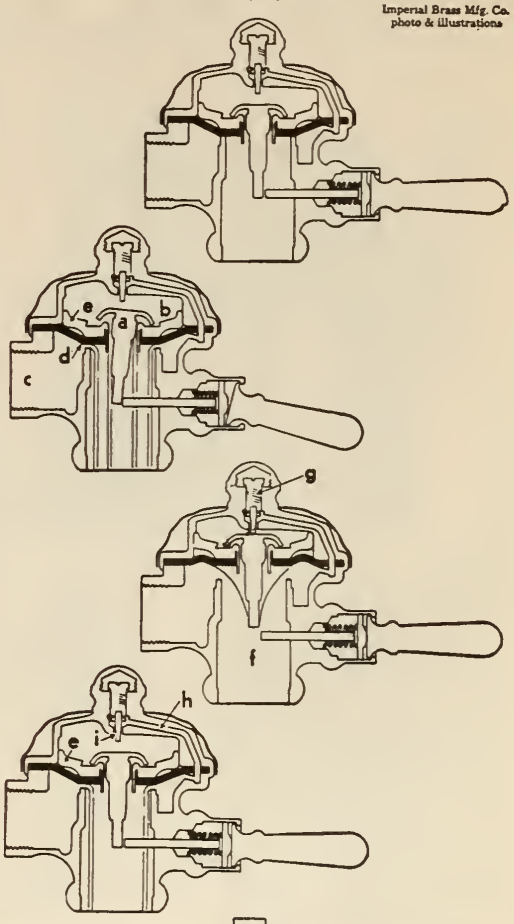
Imperial Brass Mfg. Co. photo & illustrations



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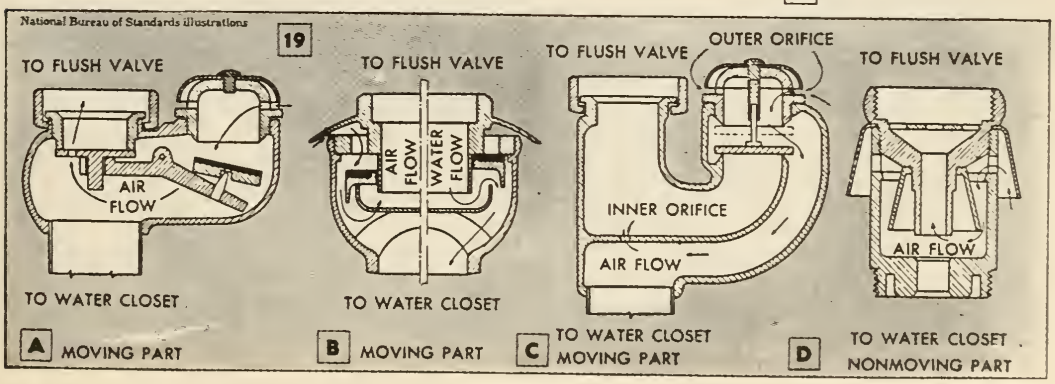

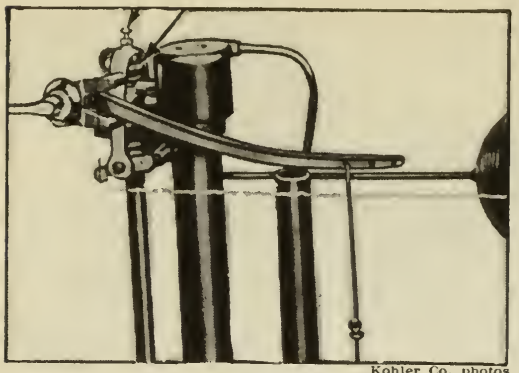

Kohler Co. photos

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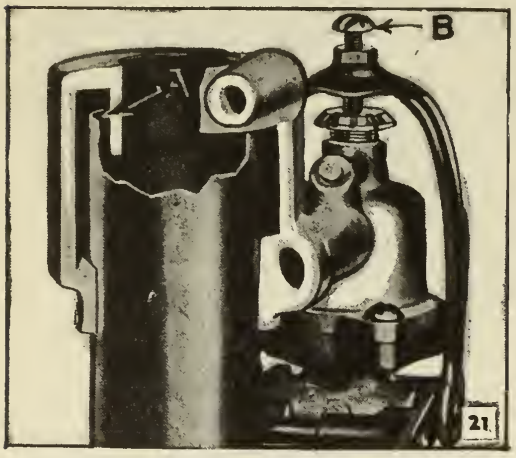

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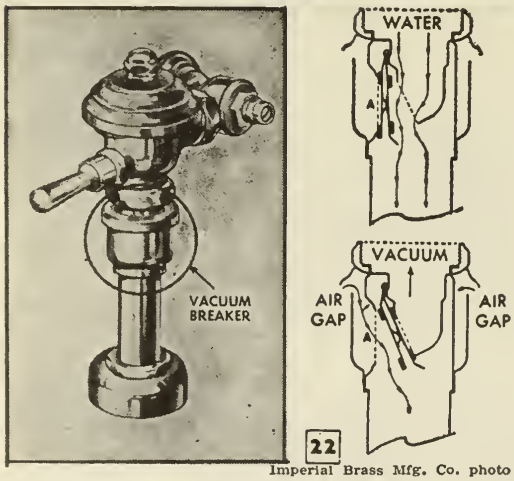

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Imperial Brass Mfg. Co. photo

directly to the water-supply line, which generally should not be less than 1 in., although ¾-in. pipe may be satisfactory for unusually high pressures. Flush valves require from 10 to 20 lbs. per sq. in. (p.s.i.) pressure. This varies with units due to the differences in design. The discharge capacity also varies with design from 20 to 40 g.p.m., but the duration of discharge is so short that the total volume of water used is less than that discharged by a tank-type water closet. The rate of flow on flush valves is often adjustable.

Flush valves use less water than flush tanks and can be operated at intervals of only a few seconds. They also take less space and generally require less servicing than the mechanism in a tank-type water closet. There are several types of flush valves, including the diaphragm, piston and plunger types. Fig. 17 shows a cutaway view of a diaphragm-type flush valve. The four views of Fig. 18 show how it operates. At the start of a flush, the handle tilts valve "a," relieving pressure in upper chamber "b," and allowing water pressure in supply pipe "c" to exert force upwards on diaphragm "d," raising main unit "e" so that maximum flow of water passes through outlet "f." Raised valve "a" pressing against the plunger on regulating screw "g," widens opening "i" to momentarily increase flow of water through bypass "h," cleaning it and filling chamber, which forces main unit down to starting position.

Backflow preventers: Fig. 19 shows four types of backflow preventers or vacuum breakers. Those in details A, B and C have moving parts, while the one in detail D has nonmoving parts. Backflow preventers are used where it is not possible to have an air gap between the water-supply outlet and the flood-level rim of a fixture. This is explained in *Water System Troubles.* A backflow preventer is placed between a control valve and the fixture. Moving parts, such as a pivoted or sliding disk, are permitted on acceptable types of backflow preventers, but they cannot include springs or other elastic or flexible parts.

The backflow preventer shown in Figs. 20 and 21 is an atmospheric type and is combined with a water-closet float valve. "A" indicates where air enters and "B" is the adjustment screw to vary height of float valve so the water level will be 1 in. below the top of the overflow tube. All flush-valve water closets should be equipped with backflow preventers installed as in Fig. 22, which also shows the working principle of this design.

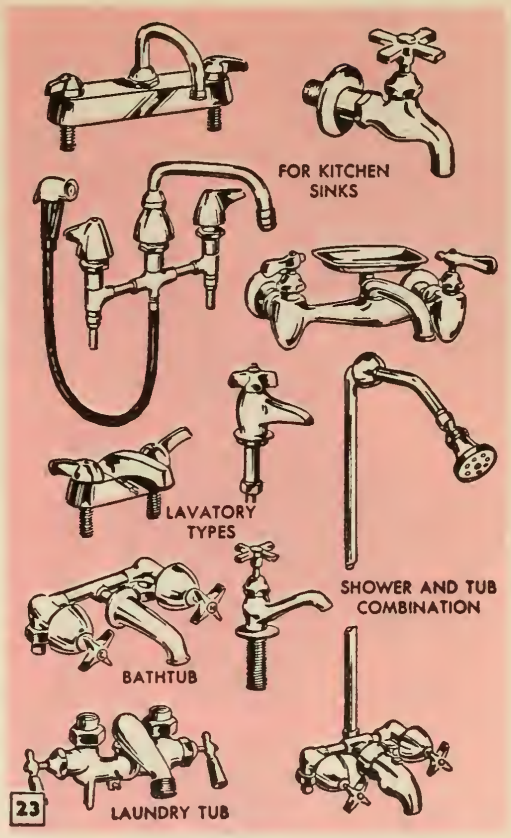
Compression faucets and sill cocks: Various styles of single and combination faucets are shown in Fig. 23. Some are connected to a common spout. Practically all modern faucets are of the compression type. Fig. 24 shows the working parts of a faucet. Notice its similarity to a globe valve. A drilled partition forms a seat against which a composition washer is brought down by a threaded spindle.

Continued dripping of water after a faucet has been tightly closed by hand usually indicates a worn washer. To repair it first shut off the water supply. Then loosen the cap nut on the faucet with a flat-jaw

wrench. Protect the chrome or nickel finish from being marred by inserting a strip of cardboard between the nut and the wrench jaws. If the cap nut is round and the edges are grooved, use a strap wrench. After loosening the cap nut, turn the faucet handle in counter-clockwise direction so that the threaded spindle unscrews. Then you can lift out the spindle assembly as in detail A of Fig. 25. It may be necessary also to turn the faucet handle at the same time to provide clearance for the nut. Next, loosen the brass screw that holds the old washer on the end of the spindle, detail B. Sometimes the screw is corroded and is so tight that it will not loosen readily. An application of penetrating oil may help. If the screw breaks off, it usually can be removed by drilling a small hole in the remaining threaded portion, and turning out the remaining shell of the screw with the tang end of a small file. If necessary, scrape away all traces of the old washer. To determine the size of a new one, measure the diameter of the recess in which it fits as in detail C. It is sometimes necessary to dress the outside edge of a washer with a file to make it slip into the washer holder.

With the new washer in place, turn the spindle into the faucet and then screw the cap nut down. If necessary, the faucet handle can be shifted as in detail D after removing the screw holding it. Some faucets, however, have handles that cannot be removed from the spindles. For example, there is one in which the spindle works in a sleeve which is lifted out with the spindle. The spindle washer moves upward against the bottom of the sleeve when closing. Replacement of the washer is practically the same, except that a nut holds the washer instead of a screw.

Refacing faucet seats: If the flat surface of the faucet seat against which the washer compresses is rough, it will be impossible to prevent recurring leaks by merely installing new washers. Such roughness is caused by corrosion or by abrasion due to sand and grit particles becoming embedded in the washer. The roughened seat should



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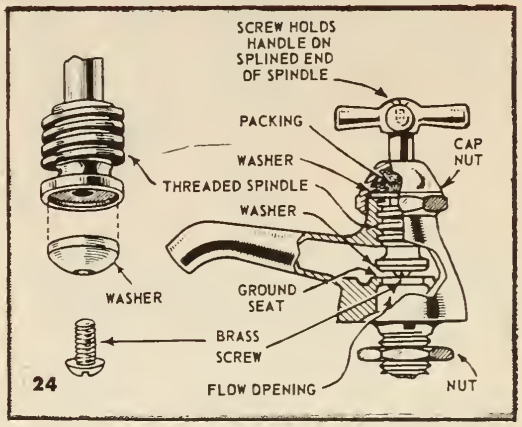

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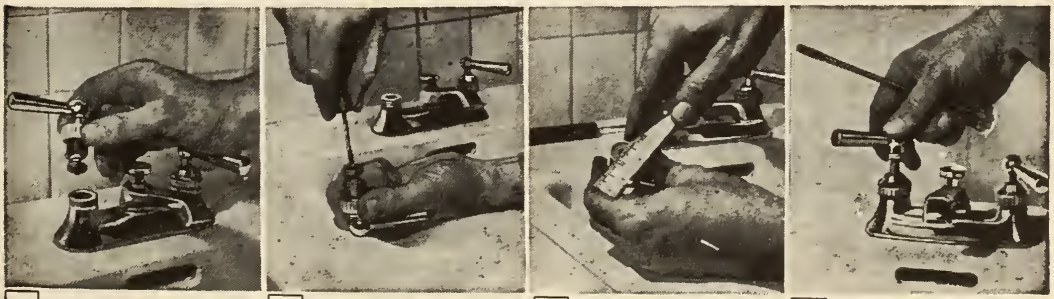
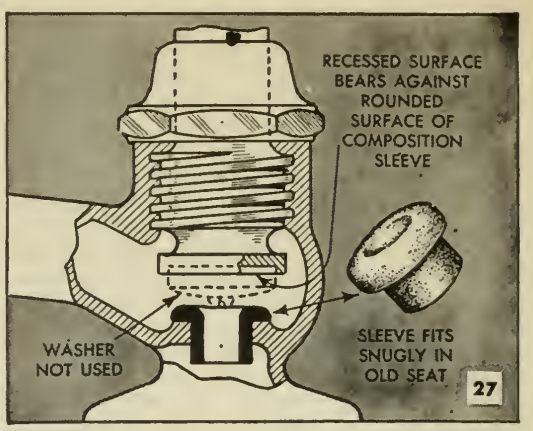
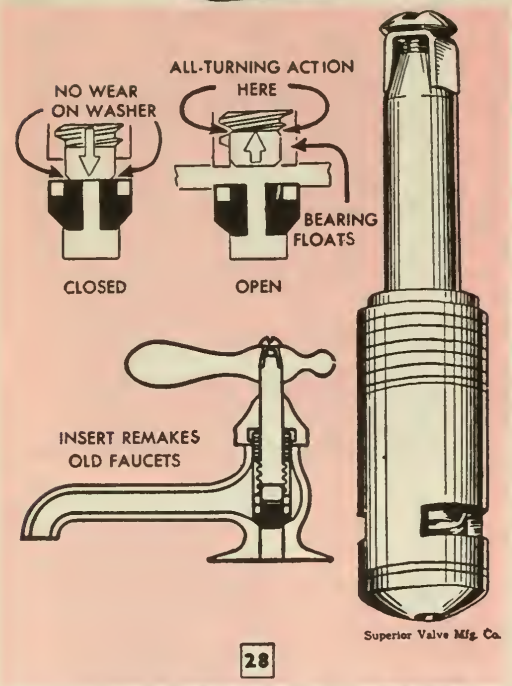
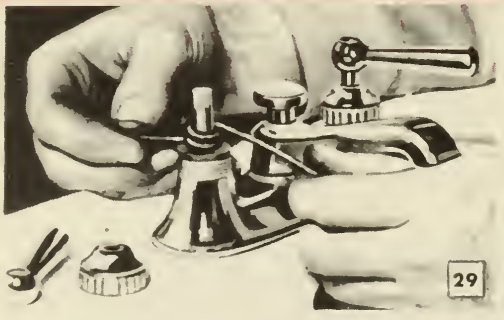


A Lift out the spindle | B Remove the washer | C Measure washer size | D Adjust faucet handle





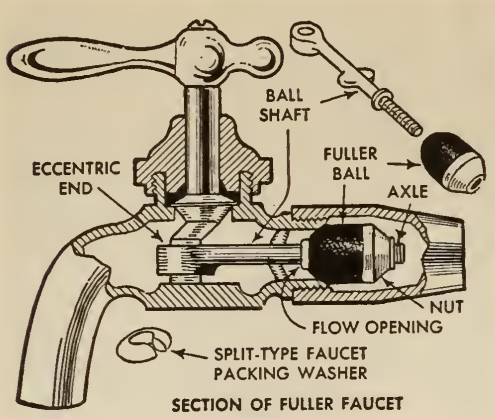


be refaced by means of the tool shown in Fig. 26. Care must be taken to hold the refacing tool vertically and to use light pressure. After refacing the seat, see that all bits of metal are flushed away before replacing the faucet spindle. Another method of providing a new seat, which eliminates the cost of a refacing tool, is to use a special composition sleeve that is pressed inside the old seat as in Fig. 27. The washer and screw are removed permanently from the end of the spindle, which then bears against the sleeve insert when the faucet is closed.

The process of reseating or refacing leaky faucets or replacing old faucets can be avoided generally by using a faucet insert of the kind shown in Fig. 28. When this insert is used it is not necessary to remove the faucet from the pipe. It provides a new stem, new seat and new threads. It has a nonturn compression shut-off (floating bronze bearing), which is held tightly against a rubber washer by the threaded spindle when the faucet is turned off. Turning the faucet on permits water pressure to force the bearing up. The washer is held in the end of the shell of the unit and does not rotate. The lower surface of the washer is held tightly against the faucet seat by the pressure exerted by the cap nut on the upper end of the shell. As the bearing simply presses down against the washer there is no rotary movement that causes the washer to wear. Water passes through two ports in the shell when the bearing is raised. The insert fits nearly all faucets. To install one, the cap nut of the faucet is unscrewed, the old faucet stem is removed, the insert put in place and the cap nut and handle are replaced.

Leaky spindle: Leaks sometimes develop between the spindle and the cap nut of a faucet. If tightening of the cap nut does not stop the leak, loosen the nut, slip it up against the handle and replace the packing. Sometimes it is necessary to remove the nut from the spindle entirely in order to remove the old packing. You can use a packing washer of correct size, or stranded graphite-asbestos wicking, which is wrapped around the spindle as in Fig. 29.

Repairing Fuller faucets: Although practically obsolete, there are still many Fuller faucets in older homes. On this type, shown in Fig. 30, the handle can be swung in either direction to open or close the faucet. A hor-



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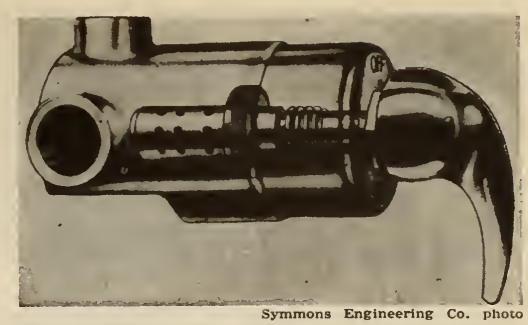
izontal spindle with an acorn-shaped rubber stopper or ball (Fuller ball) at one end is moved back and forth by means of a crank-shaped vertical spindle to which the handle is attached. The entire faucet must be removed when the ball is adjusted or replaced. The sleeve enclosing the ball is unscrewed if the nut that holds the ball cannot be reached with a long-nose pliers. Turning the nut to bring the ball closer to the seat may stop the leak, or a new ball may be required. A worn spindle or ball shaft can be replaced at small cost.

Mixing faucets: Combination faucets to mix hot and cold water are in common use for kitchen sinks, lavatories, laundry tubs, bathtubs and showers. They cannot be depended on to keep the water at a uniform temperature. For example, when water is drawn from another outlet while a shower is being used, the temperature of the shower water may fluctuate widely because of the reduced pressure. This may result in an extremely cold or in a scalding mixture, with possible serious consequences.

Automatic mixing valves for showers: Temperature of shower water can be maintained within a few degrees even when there are pressure drops of as much as 90 percent in either hot or cold-water line. This is accomplished by means of a pressure-controlled mixing valve such as shown in Fig. 31. Fig. 32 shows the exposed portion of a slightly different model having a control valve that directs water to either shower or bath. The mixer consists of a cylinder containing a free-moving, pressure-equalizing piston. The latter is actuated by cold-water pressure at one end and hot-water pressure at the other, which directly controls the amount of hot and cold water admitted and so maintains the temperature of the mixed water as originally adjusted. The interior of the valve is completely accessible from the front for replacing washers or the seat unit, should this become necessary. The valve shown is



Symmons Engineering Co. photo

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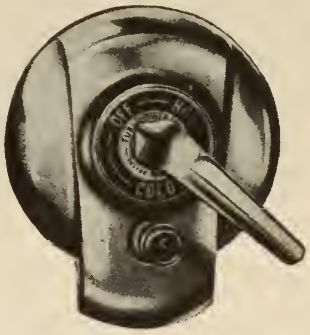

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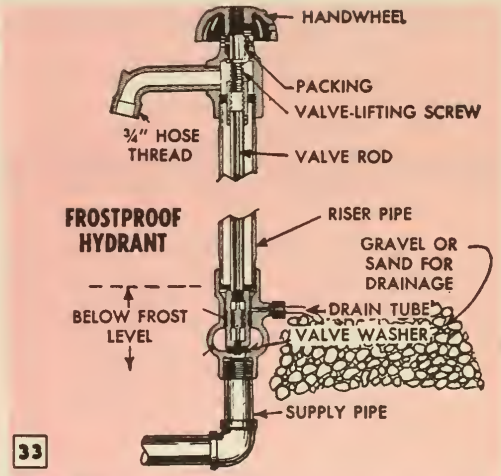

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the concealed model with only the handle and front plate visible. Exposed models also are available. Thermostatically controlled mixing valves also are available.

Frost-proof hydrants: Where an outdoor outlet is connected to an underground supply pipe and is used the year around in localities where the outlet is likely to be damaged by frost, a frost-proof hydrant, Fig. 33, has the great advantage of being trouble-free. The valve is located below frost level and is operated by an extension rod. When closed, the valve drains off water from the riser pipe. A gravel or sand bed, as indicated, permits rapid dissipation of the drained water. Insulating the riser pipe helps to prevent ice formation inside.

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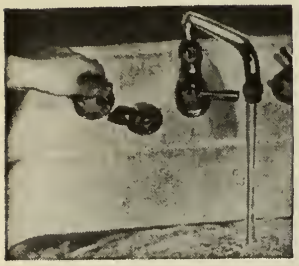

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Don't pour cooking fats and grease into kitchen sink but discard with garbage and wipe away traces from pans with paper towels or napkins before washing

Flush sink drain with scalding-hot water for 2 or 3 minutes each day. When waste pipe is clogged, remove trap so drain auger can be easily advanced to obstruction

5

Drainage Troubles-Causes and Cures

Among troubles experienced in drainage systems, the most common ones are clogging of pipes, especially those from kitchen sinks; root penetration into house sewers; backflow of sewage into house drains and the entrance of sewer gas into houses. Less common are freezing of drainage lines, leaky pipes and drainage-system noises. Some of these troubles can be remedied easily by most homeowners; others are more involved but can also be done by homeowners at a considerable saving in cost. In any case the problem encountered becomes much easier to solve when you can diagnose it correctly, locate its source and know where and how to apply an effective remedy. Besides curing an existing trouble, measures should be taken in order to prevent its recurrence.

Clogged sink drains: Most stoppages in kitchen-sink waste lines are caused by accumulations of congealed grease and fat emptied into the sink. Coffee grounds, food particles and lint are held in this grease deposit which gradually builds up until it obstructs the pipe completely. Generally the trouble occurs in a horizontal portion of the waste pipe. Therefore this part should always be provided with an accessible cleanout, shown in Fig. 8.

Too steep a slope in this section also causes the water to drain away fast which is apt to leave solids stranded in the pipe which will obstruct it. If part of a sink-waste pipe is enclosed in an outside wall, as in Fig. 8, grease is likely to congeal here. Clogging seldom starts at the trap, as hot water running through it constantly at dishwashing times tends to keep it clear. The amount of this hot water, however, is seldom enough to heat the waste pipe and melt grease at some distance from the trap.

Fat, grease and oil never should be discarded into a sink, lavatory or water closet. Fats, as well as hardened crusts scraped from cooking utensils, and leftover bits of food should be collected in cans that can be thrown away with garbage, Fig. 1. Remaining traces of grease should be wiped up with paper towels or napkins as in Fig. 2.

The most effective method of preventing stoppage from congealed grease and oil that

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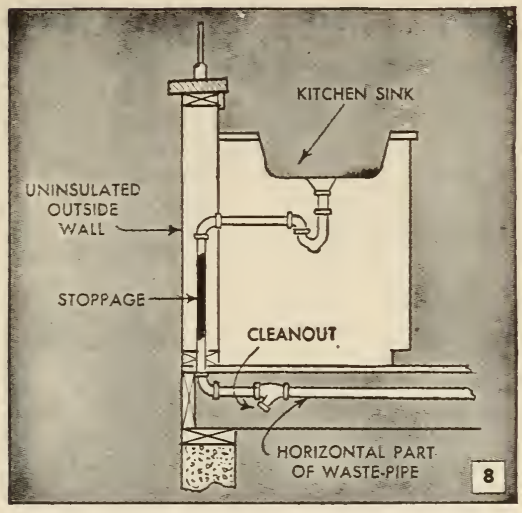
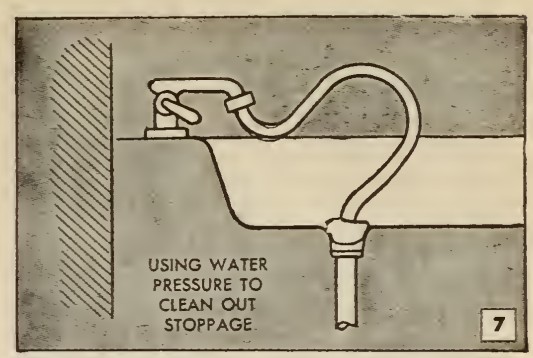


are carried into a drain with dish water, is to run a copious amount of scalding water through the pipe for a period of at least 2 or 3 minutes after each dishwashing, Fig. 3. As soon as drainage through the pipe slows up, practically an entire tankful of scalding water should be run through it. The temperature control on the water heater should be set to "high" about an hour or so before such flushing.

Drain-pipe chemicals: If the scalding water treatment does not open up a slow drain, you can use a strong chemical cleaner. Most of these consist of sodium hydroxide (caustic soda), with bauxite and other ingredients added to intensify their action. Mixtures of caustic soda with sodium nitrate and aluminum turnings are also used, in which case ammonia gas is formed and dissolves the grease. The use of lye (caustic soda) alone frequently adds to the grease



accumulation more rapidly than it can be removed by water and then increases the stoppage. When added to water these chemicals effervesce violently and produce considerable heat.

As these drain-cleaning chemicals are extremely caustic they must be handled with care to avoid getting them or the solution on hands, arms and face. Also avoid splashing the chemical on clothes, wood, painted surfaces or aluminum. If this happens accidentally, flush with cold water, then immediately apply vinegar and finally rinse with cold water. After the chemical has been put in the drain pipe, do not use a plunger to hasten the removal of the grease accumulation. Keep water out of the can containing the chemical; if the content is wetted and the can lid is closed tightly, sufficient pressure may be produced inside to cause the can to "blow up."

A chemical cleaner should not be used in drain pipes that are completely clogged. It is necessary to have a slight flow to carry the chemical down to the point of obstruction, since it must be in contact with the obstruction to be effective. Pouring the chemical into a sink drain merely lets most of it settle in the trap. The best method is to remove the trap, as in Fig. 4, and insert the chemical in the pipe beyond the trap location as in Fig. 6. Use about a quarter of a full can and wash it down the pipe by slowly pouring in about a quart of water at intervals. Then replace the trap and after about 15 min. check to see if water drains away faster. Repeated chemical treatments are sometimes necessary. When good drainage is resumed, flush the pipe with scalding water for about 5 min.

Mechanical methods: When a sink or lavatory drain is completely stopped, mechanical methods must be employed usually to remove or pierce the obstruction. First try a suction-cup plunger, as in Fig. 5, a force pump, or use water pressure from a faucet, Fig. 7. In this case the hose must be securely attached to both faucet and sink drain. Be sure that there is enough water in the sink to provide a good seal when using a suction cup, and then work it up and down

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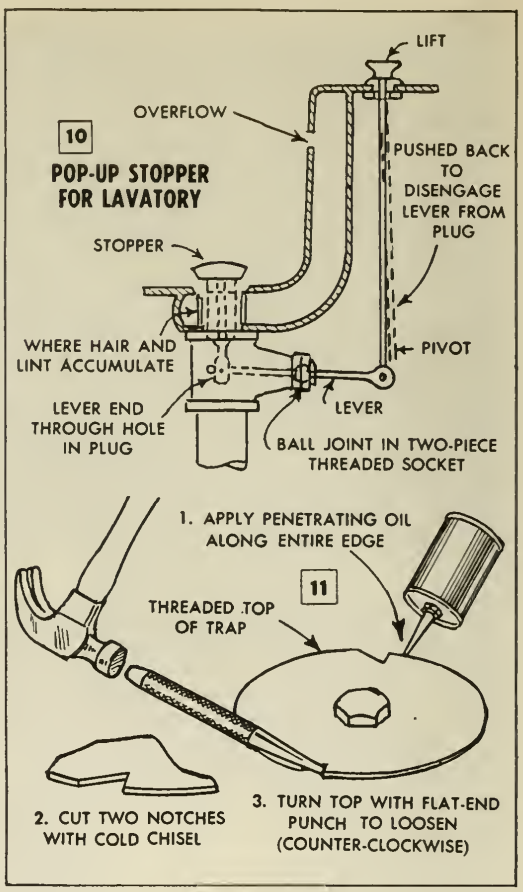

with quick, forcible strokes. These methods can be effective only when the obstruction lies between the sink and a vent pipe. If it lies beyond the vent pipe, air is admitted, which makes the suction cup ineffective. If water pressure is used, water will run up into the vent pipe instead of providing a positive pressure against the obstruction.

When these methods do not dislodge the obstruction, run a 15 to 25-ft. by ⅜-in. drain auger through the pipe, as in Fig. 9. Remove the trap and elbow from the pipe and feed the auger into it. Rotate it, then feed in farther and rotate again, continuing in this way until you have pierced the obstruction. If the latter cannot be reached conveniently from the sink location, open the cleanout plug at the beginning of the horizontal section and insert the auger at this point. It is impossible to remove all the grease from a pipe with an auger, but after a hole has been bored through the grease you apply the chemical treatment followed with a thorough flushing with scalding water.

An alternate method is to heat the pipe in order to melt the grease. You can use a blowtorch flame against the pipe if there is plenty of clearance between it and other inflammable material near it. An asbestos shield should be used to protect the latter from the flame.

Lavatory drains: Many lavatories have a pop-up type of drain stopper, Fig. 10, which tends to accumulate hair and lint just below the lavatory outlet. A length of wire having one end bent to a small hook can be used to pull out this accumulation, after removing the stopper. To do this you unscrew the ball-joint socket so that the short horizontal lever can be disengaged from the lower end of the stop plug. If the trap is clogged it may be cleared sometimes with a suction cup; in obstinate cases, it may have to be removed for cleaning.

Bath drains: Accumulations of lint, hair and pieces of soap can cause clogging of bathtub and shower drains. Soap usually dissolves in a short time and passes away. When an accumulation clogs the trap and stops drainage flow, the cover of the trap must be removed, as in Fig. 11, to clean it. Turning the cover loose often can be made easier by letting some fine oil run over the edge of the cover and onto the threads. Tap the cover lightly while applying turning force. If it does not budge, chip two notches in the edge with a cold chisel and use a driving punch and hammer to turn the cover. When replacing it, be sure that the fiber gasket is thoroughly clean and in good condition. If defective, replace it rather than take a chance on admitting sewer gas. Putting a small amount of cup grease on the threads will make it easier to screw on the cover and will help also in getting a tight seal.

Water-closet stoppages: When a water-closet drain is stopped (usually paper causes this), try dislodging the obstruction with a suction cup first. If the suction cup is not effective, use a water-closet auger, although an ordinary drain auger can be employed. Often paper is caught by the spiral tip of the auger and can be pulled

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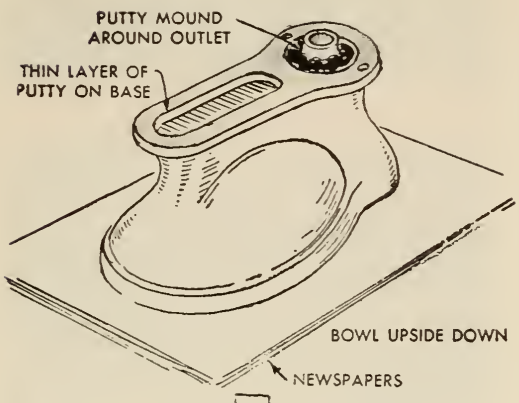

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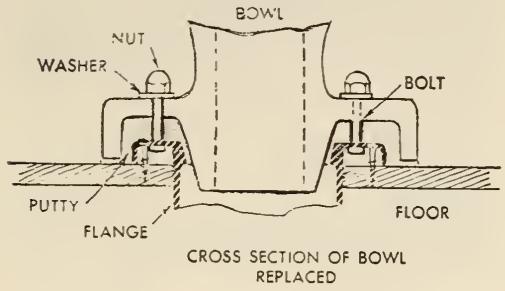

CROSS SECTION OF BOWL REPLACED

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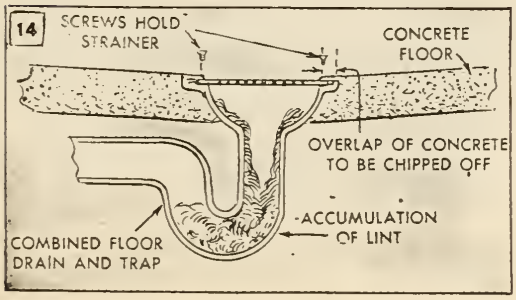
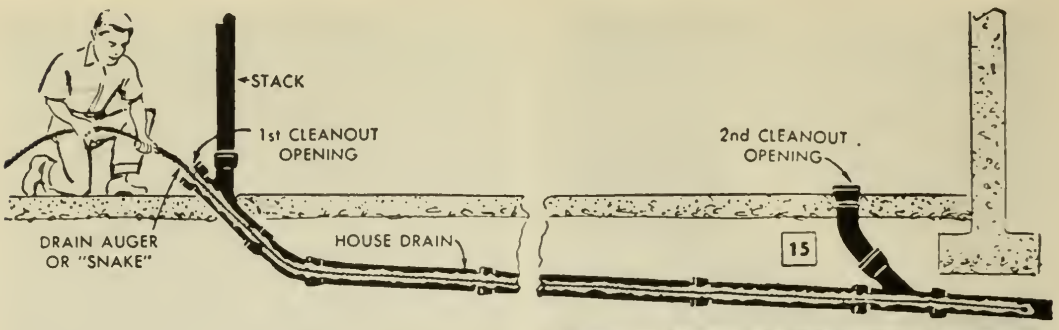


back. If a cake of soap is lodged in the trap, traces of it will show on the end of the auger. Soap is not easy to remove, but a quantity of hot water poured into the bowl will soften the soap and permit it to wash away.

Removing closet bowl: If the obstructing object cannot be removed with these methods, and it seems to be wedged in the trap, it will be necessary to remove the closet bowl to get at the obstruction from the outlet opening. First shut off the water supply and empty both the tank and the bowl by siphoning or pumping and sponging. Then disconnect the water-supply pipe to the tank, loosen the bolts holding the tank to the bowl if any, and also loosen the pipe connection between the tank and bowl, after which you can lift the tank off and carefully set it aside on newspapers. Some bowls can be removed without the need of removing the tank by only loosening the connection between the two. Next, remove the seat and loosen the bowl where it attaches to the floor, Fig. 12. Jar the bowl by hand to free it from the putty seal or gasket between the bowl and flange. Then lift off the bowl and set it upside down on newspapers. In this position the discharge opening is accessible.

Replacing closet bowl: Before replacing the bowl, clean away old putty from the base and flange. Dry the surfaces thoroughly and apply new bowl-setting putty to both bowl and flange, as shown in Fig. 13. About 3 lbs. of bowl-setting putty will be required; ordinary putty cannot be used. Build up a mound of putty around the outlet opening or "horn" of the bowl. Also apply a thin layer to the base where it contacts the floor, but keep the bolt holes clean. If a gasket is used instead of putty, replace it rather than take a chance on the old one. Contacting surfaces, in case a gasket is used, should be thoroughly clean. When replacing the bowl get it in exactly the same position as it was originally. Press it down to squeeze out the surplus putty and replace the nuts, tightening them carefully until the bowl rim is level. Then reconnect the tank if it was removed. If there is any water leakage from the puttied joint, take off the bowl again and reset with more putty. The bowl and tank should be handled with utmost care. They are made either of porcelain or vitreous china and can be chipped and scratched easily.

Floor drains: Floor sweepings and lint from washing clothes may cause floor drains to clog. Often the strainers, which are removable, are firmly held by the concrete floor which then must be chipped away a little in order to free them, Fig. 14. A long-handled spoon or ladle is handy to remove sediment from the trap, although



a drain auger may be needed to loosen hard accumulations. When an opening has been made, you can apply water pressure from a garden hose to flush out the trap. If the trap is closed with congealed grease, first use a drain auger followed by a chemical drain cleaner and afterwards scalding water, as already explained. It is best to clean out floor drains periodically instead of waiting until they are completely stopped and the floor is covered with water.

Stoppages in house and storm drains: Where city sewers are not overtaxed and storm water from sewers does not back up into a house, the rise of water and sewage through floor drains indicates stoppage either in the house drain or in the house sewer. The cleanout, which usually is provided at the base of the soil stack, is the starting point for using a large drain auger or a spring-steel "snake" fitted with a spearhead. If drainage is restricted but is not entirely stopped, the obstruction can sometimes be flushed away by water pressure from a hose, in which case the nozzle is left on the hose and is adjusted for maximum force. If the obstruction is not found before reaching the cleanout opening at the outlet end, as in Fig. 15, you continue from this opening. When brass covers of cleanout openings are hard to remove, follow the same procedure of loosening them as explained for drum traps.

Where downspouts for roof drainage connect to storm or combination drains, soggy leaves sometimes cause obstructions, especially at turns. Remove the downspout and proceed with a drain auger until the mass of leaves has been loosened sufficiently to permit flushing them away with a hose. Leaf guards in gutters at downspout leaders avoid such trouble.

Root-filled house sewers: If the house drain is clear, but water from waste and drain pipes within the house causes flooding of the basement floor, the stoppage obviously must be in the house sewer or main sewer. This is reached through the cleanout opening which is closest to the outlet of the house drain. Penetration of tree roots into sewers is the most common cause of stoppage. Fig. 16 shows a section of pipe

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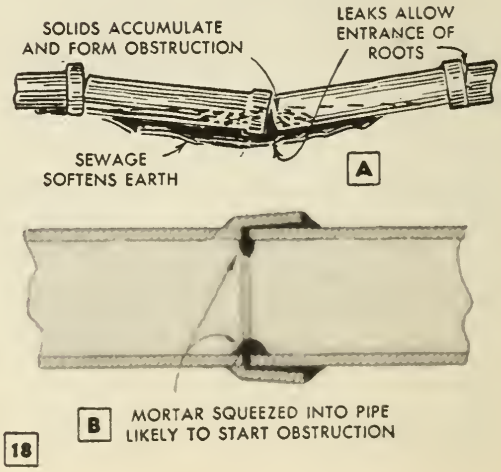

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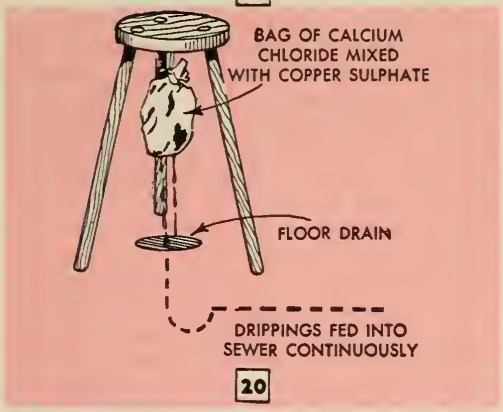

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completely filled with tree roots. Some trees, particularly willows, poplars and cottonwoods, often send their roots out as far as 20 or 30 ft. in search of water. Slight cracks often found at mortar joints of pipe are enough to admit the hair ends of roots, Fig. 17. Once inside the pipe, roots grow fast and send out countless new roots. Any kind of pipe that has a leaky joint or a cracked wall is subject to root invasion. Other causes of stoppage in sewer lines are sagging sections of pipe in filled earth, as shown in Fig. 18A, mortar at joints that has gotten inside the pipe and was not wiped away, detail B, and filling up of broken pipes that have been crushed when not buried deeply enough, or have burst due to freezing.

Temporary control measures: The best tool for cutting roots inside a sewer pipe is an electrically driven root-cutting tool, shown in Fig. 19. Plumbers in localities that are especially subject to this trouble usually have such equipment. Cutting the roots and cleaning out the line, however, is only a temporary measure for immediate relief and does not prevent recurrence.

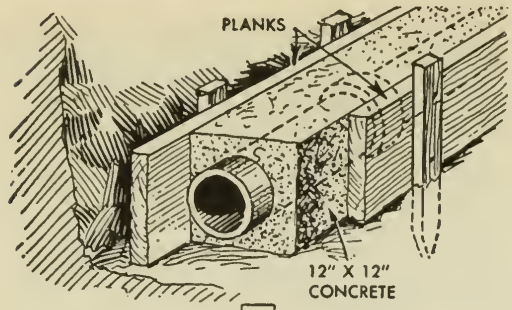
Other temporary control measures consist of applying some chemicals that kill or retard root growth. Repeated applications of caustic drain-cleaning chemicals retard root growth. Copper sulphate (blue vitriol) kills roots if applied in sufficient concentration over a period of time. One way to apply it continuously is to keep a strong solution in a container over a floor drain, arranging it so that the liquid will drip into the drain. The container can be provided with a petcock or with a suitable wick for slow, continuous dripping. Another dripping method, applicable where the air in a basement is sufficiently humid, is to mix copper sulphate and calcium chloride and hang the mixture in a porous bag over a floor drain, as in Fig. 20. The moisture retained by the calcium chloride dissolves the copper sulphate and drippings of both are fed into the sewer.

A single application of any chemical solution is not effective as it runs down the sewer and contacts the roots only momentarily. A 24-hr. or longer soaking application can be made if the house-sewer outlet can be plugged so that the solution will be retained in the line. However, as roots usually enter a sewer pipe through cracks at the bottom of joints where liquid is constantly available, the drip method is usually sufficient. Copper sulphate should not be introduced into a drain or sewer containing grease, as the chemical will coagulate the grease and form a nonsoluble substance that can cause further clogging. The application of chemicals should be greatest during spring and early summer months when root growth is rapid.

Replacing sewer pipe: The only permanent cure for root invasion is to seal the pipe joints so that roots cannot enter. If the pipe is not broken it is possible to enclose it completely in a layer of concrete as shown in Fig. 21, although the work and cost involved are no less than laying new pipe. Generally only a section of the line must be replaced, but while the job is being undertaken, it is often best to renew the entire line properly as assurance against future trouble.

Mortar joints of vitrified-clay pipe often are defective because of careless workmanship, although mortar joints properly made can be rootproof. Special pipe-joint compound, which is poured hot and remains slightly flexible, gives lasting protection when correctly applied. When replacing a section of vitrified-clay pipe, the damaged portion is broken up and removed, after which new pipe is laid. The joints are first calked, then sealed with pipe-joint compound. Fig. 22 shows how the two last sections of pipe can be fitted together so that the hub of one section need not be broken.

Other types of pipe are of value in preventing root invasion. On some types the



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METHOD OF SLIPPING TWO NEW TILE LENGTHS IN PLACE

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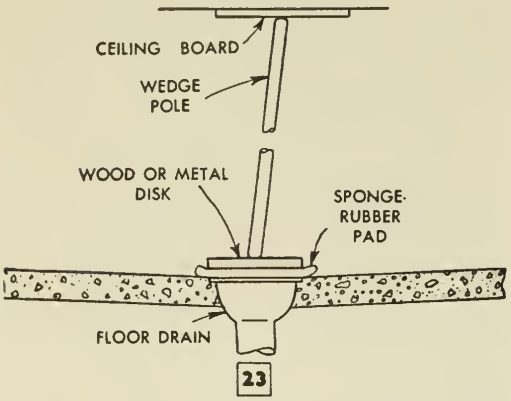

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joints can be wedged together tightly in couplings; others have heavy-duty rubber-band seals that are forced between pipe ends and couplings. Cast-iron soil pipe with tightly leaded joints also gives adequate protection against root penetration.

Backflow from sewer: In localities where city sewers are overtaxed and occasionally cause sewage to back up into houses, the best remedy is to install a backflow valve. This is placed in the house drain. Temporary measures of preventing sewage from rising in basements through floor drains consist of sealing the drains with sponge-rubber disks held down tightly under wood or metal disks with a wedge stick, as in Fig. 23. In cases where the sewage may rise into a water closet located in the basement, the bowl must be plugged tightly in a similar or other effective manner.

Frozen drainage lines: A house sewer and other buried drainage lines should be below frost level to prevent freezing. Where this is impossible the lines should be insulated and the insulation wrapped in a moistureproof covering. Freezing of inside drainage lines can occur only when a house is left unheated, or when drainage lines are located in unheated spaces. Measures to prevent them from freezing should be taken when the lines are installed. When freezing does occur, the most effective measures to thaw out the frozen section depend on its location and accessibility.

In crawl spaces and other unheated places having sufficient room, a blowtorch can be used to heat the pipe if nearby wood and inflammable materials are protected with asbestos board. The flame must not be applied at joints of cast-iron soil pipe. This may melt the lead. Rags also may be wrapped around the pipe and kept soaked with hot water, or an electric heater can be set under the frozen section of pipe. After thawing the ice inside—or grease congealed by low temperature—it should be insulated to prevent recurrence and a quantity of hot water run through it daily during cold weather. If a crawl space is located next to a basement, an opening between the two can be made to admit some heat into the crawl space. In this case, the walls should be insulated. Vertical lengths of drainage pipe in outside walls can also be protected against freezing if the space between studs is provided with some heat from the basement. To thaw out a section of such a pipe, hot air from an electric heater-fan is directed into a basement opening.

Besides heating a pipe from the outside, it can also be heated from the inside. Assuming that it is full of water above the frozen section, it is best to run a hose or length of rubber tubing into the pipe and down to the obstruction so that the water can be pumped out. Then the pipe may be filled with scalding water, or chemicals may be introduced. A chemical cleaner which generates considerable heat can be flushed down to the obstruction. Another chemical that has been found effective is antifreeze of the kind used in auto gas tanks.

Protecting traps in unheated houses: Considerable damage in a drainage system can result by leaving water in traps and water closets in an unheated house when it is closed during cold weather. The water freezes and cracks the traps or closet bowls. Proper precautions to prevent this consist merely of removing all water from the traps and substituting a nonvolatile oil, such as kerosene, which will not congeal. Water is easily removed from washdown-type water closets by sponging out the trap. All siphon-jet water closets cannot be completely emptied in this manner. Those having a jet hole in the bottom of the bowl can be emptied by inserting a rubber tube through the hole and pumping out the water from the passage below the bowl. To protect water systems from frost, see *Water-System Troubles and Cures.*

SLAVE ANODE ARRESTS CORROSION

By James Joseph

HERE IS HOW you can minimize corrosion in your hot-water heating and underground sprinkling systems. Simply attach a sacrificial magnesium anode to the system to divert the attack of the corrosion-producing electrical current from the steel tank or pipeline to the magnesium; as illustrated in this article. Copper tanks and pipes usually are not affected to any extent by such electrochemical reaction, called galvanic action. The latter can occur only when dissimilar metals are in direct contact with one another in a slightly acid solution (electrolyte, a situation that is quite the same in a dry-cell battery, Fig. 8. Usually the softer metals that are alloyed with the iron in a tank or pipeline (copper in this case) serve as the cathode part of the electric cell and the iron functions as the anode. The water that comes in contact with them normally contains sufficient impurities to act as an electrolyte, making it possible for electrical current to travel from the anode to the cathode through the medium of the electrolyte. In an unprotected hot-water tank or pipeline this results in loss of the steel metal which appears as rust.

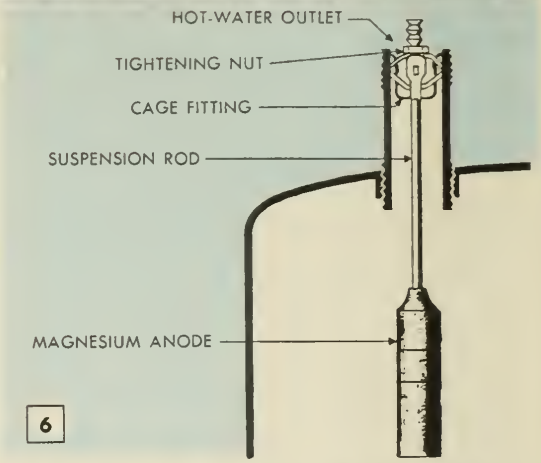
Glass-lined tanks are protected from galvanic action, provided the steel surface remains completely covered throughout their use. To guard against the possibility of voids in the lining material, most heater manufacturers insert a magnesium anode in their tanks as detailed in Fig. 6. Since magnesium acts as an anode when associated with steel, the flow of current is reversed to "eat away" the magnesium anode, instead of tank surfaces that may be ex-

Above, magnesium anode is packed in quick-wetting backfill that is buried with anode to retain ground moisture, assuring constant flow of electrical current

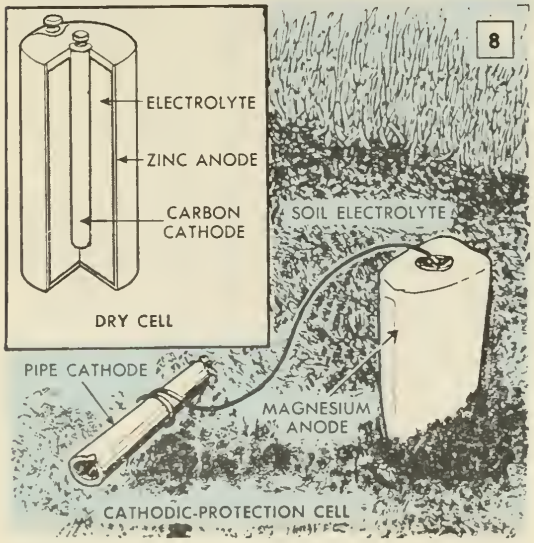
Above, lead wire from magnesium anode is soldered to cleaned surface on sprinkler pipe. Figs. 3 and 4, after backfill is poured around anode, it is saturated with water and completely covered with soil

posed. Such an anode should last from two to six years, depending upon the amount of electrochemical action in the tank. Then it can be replaced at nominal cost.

If you have an unlined steel tank, it can be protected from rust by installing a magnesium anode in it as shown. Such anodes may be purchased at most large plumbing-supply stores. Easily installed anodes are of two types: Rigid, for locations where there is 4 ft. or more of clearance above the tank; flexible ones for tanks that have less than 4 ft. of overhead clearance. Also, anodes come in various sizes according to the tank's capacity in gallons. Whether rigid or flexible, an anode is a ¾ to 1-in.-dia. rod of magnesium cored with a $\frac{3}{32}$-in. plated-steel wire and equipped with a suspension rod and cage fitting for installing



Figs. 5 and 6, when there is limited clearance above hot-water tank, flexible magnesium anode is used

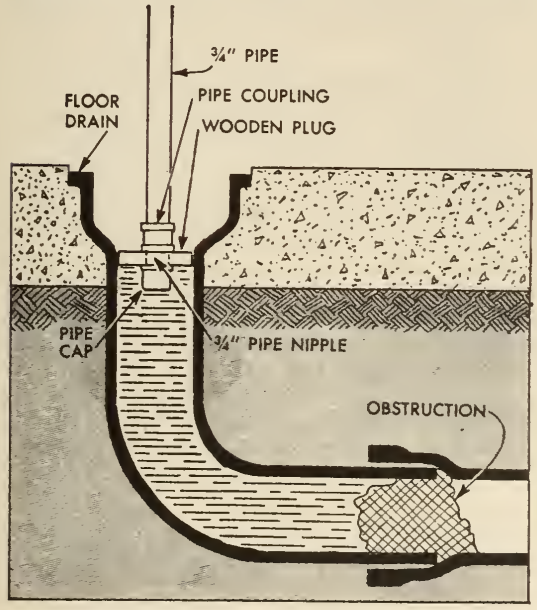


the unit in the nipple of the hot-water outlet at the top of a tank.

When installing an anode: First shut off the water supply to the heater and partially drain the tank. Then disconnect the union at the upper end of the nipple, remove the latter and push the hot-water pipe aside to clear the tank opening. Next, lower the anode into the tank, until the cage fitting is flush with the top of the nipple when pressed into the latter, Figs. 5, 6 and 7. Secure the tightening nut on the cage fitting and reconnect the hot-water line to complete the installation. To assure continued protection, the anode should be removed for inspection each year following the second year of the installation. When the magnesium is "worn" nearly to the core metal, it is time to replace the anode.

To provide similar protection for your underground sprinkling system, connect a magnesium anode of the proper size to one of the pipes. Anodes used for this purpose usually are packaged with a quick-wetting backfill as shown in Fig. 1. When digging a hole for burial of the anode, select a section of the pipe that lies in a moist area, preferably where the sprinkler keeps the ground quite wet. Then expose about 1 ft. of the pipe and scrape bare a few inches of the galvanized coating. Next a hole is dug adjacent to the pipe so that 6 to 8 in. of soil will cover the anode when it is in place. After the lead wire protruding from the top of the anode is soldered to the pipe, the backfill is poured around the anode, Figs. 2 and 3. Then the backfill is thoroughly saturated with water, Fig. 4, and the anode and pipe are covered with soil. Some anodes have a terminal at the top in place of a lead wire, in which case an insulated TW-12 (copper) wire should be brazed to the pipe and the other end fastened to the terminal. Anodes for protecting sprinkling systems against rust may be purchased from companies that sell the systems. ★ ★ ★

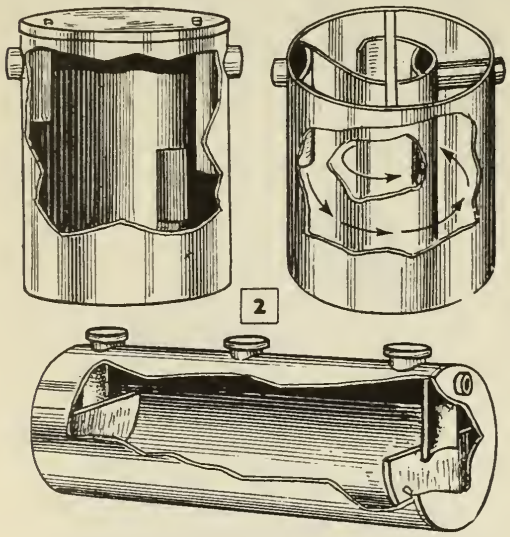
Special Force Cup Clears Obstructions From Floor Drains



Surface drains in floors, driveways and sidewalk areaways can be quickly cleared of obstructions with this homemade plumber's "force cup." It consists of a 3 or 4-ft. length of ¾-in. pipe and a wooden disk which is held to the lower end of the pipe by means of a pipe coupling, short nipple and cap. The wooden disk is a sliding fit inside the drain. Rounding the edges of the disk will help insert it. A length of beaded weather stripping, or a piece of inner tube, tacked around the bottom edge of the disk acts as a seal for more efficient use of the tool. To clear a drain, first be sure it is full of water, then insert the tool, forcing it quickly down as far as it will go. Repeated up and down motion will force the water in the drain down against the obstruction to push it free. Be careful that the wooden "piston" doesn't become jammed in the drain.

SAFE SEWAGE

How to install and maintain a septic-tank disposal system for rural and suburban homes



VERTICAL AND HORIZONTAL TYPES OF STEEL SEPTIC TANKS. CONSTRUCTION OF VERTICAL TYPE AT RIGHT PREVENTS DISCHARGE OF UNSETTLED SEWAGE.

IN RURAL AND SUBURBAN AREAS where there are no sewage facilities, a septic-tank system is the most practical means of sewage disposal. Any home that has running water can have such a system, and once you know how the system operates and what it requires, planning it presents few problems. Plenty of digging is required to install the system, but it is possible to rent motorized equipment to reduce the labor to a minimum.

A typical septic-tank layout is shown in Fig. 1. Ready-made steel tanks, Fig. 2, or precast concrete, Fig. 3, or tanks of vitrified-clay pipe are available. Also, you can pour concrete tanks on the site. Before planning a septic-tank installation, get a copy of your state's code on individual disposal systems and follow its provisions explicitly.

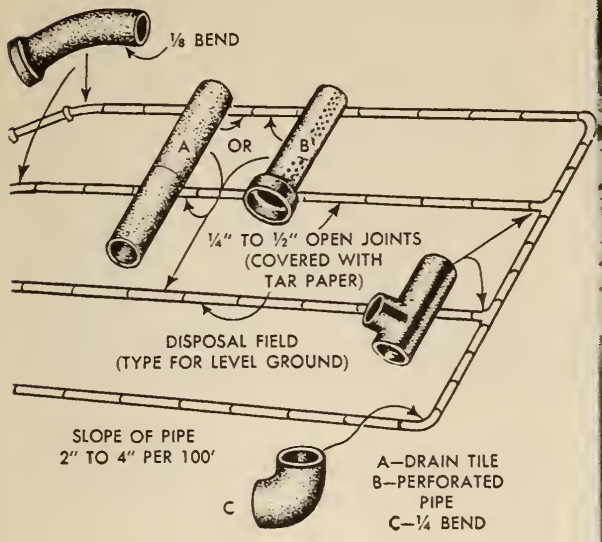
How a septic-tank system works: Solids entering the tank settle and form a sludge at the bottom. Grease and lighter particles rise to the top and form scum, as in Fig. 4. Organic matter in the sludge and scum is decomposed by types of anaerobic bacteria that thrive in the absence of light and air. Gases caused by the bacterial action escape through the house sewer and vent stack. The remaining liquid, called "effluent," collects between the sludge and scum. When it reaches the level of the tank outlet it flows out in amounts equal to the raw incoming sewage. Sewage should be fermented in a septic tank from 24 to 72 hrs. and longer in a two-chamber tank.

The effluent runs to a disposal field, where it seeps into the soil and is made harmless by aerobic bacteria. These, unlike anaerobic bacteria, require air for life and thrive near the surface of the soil, mostly within the first 36 in. Therefore, disposal lines must not be too deep.

Selecting the site: When planning a septic-tank system, first select the site for the disposal field. Its size depends on the sewage load and the absorptive quality of the soil. After determining the size, select the site in consideration of these qualities:

1. Distance from water sources. To avoid pollution, this should be 100 ft. or more. The disposal line should be 25 ft. from any

DISPOSAL



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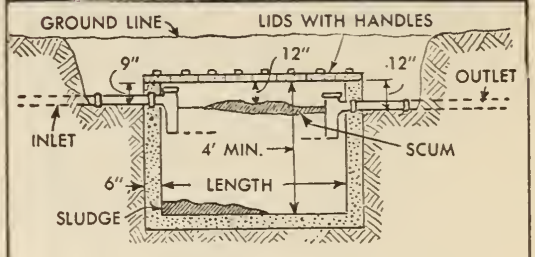
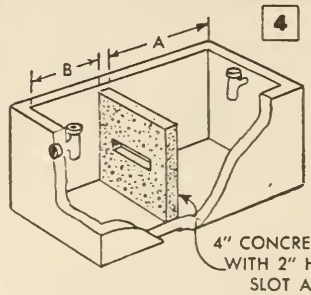
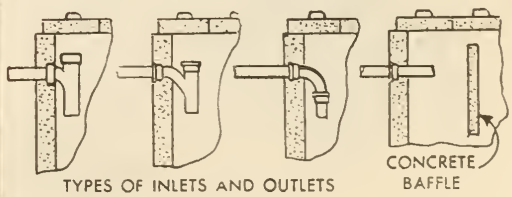


Above, the working capacity of a septic tank is the area below the outlet. Sufficient space must be allowed above the scum layer to permit proper operation. Gases which are generated escape through the inlet pipe to the house sewer and then out through the vent stack





stream and 10 ft. from a house or lot line. A distance of 50 ft. from a drilled well is safe if the well casing is watertight to a depth of 50 ft.

2. If possible, the field should be exposed to wind and sunlight.

3. The ground should be well drained, sloping away from the house and water supply.

Septic tanks: Size of the tank depends on the sewage load. Table A gives the measurements of concrete tanks of various sizes. Consult the manufacturer's data sheets for the capacity of prefabricated tanks. It is better to have a tank too large than one that just meets minimum requirements. When determining the size, consider future additions to the plumbing system. The actual working capacity of a tank is the space below the outlet. The minimum size of a one-chamber tank is 500-gal. working capacity. A two-chamber tank, Fig. 4, is more efficient and requires cleaning less often; the minimum size is 750 gal. The tank outlet usually is about 3 in. lower than the inlet. Sufficient air space should be provided above the working capacity. Any of the inlet and outlet arrangements shown in Fig. 4 will prevent turbulence in the tank when sewage flows in, and also keep the scum from flowing out. The covers should fit tightly and may be sealed with a plastic compound to keep out ground water. Large tanks should have manholes, one near each outlet. Usually a septic tank is set so that it can be covered

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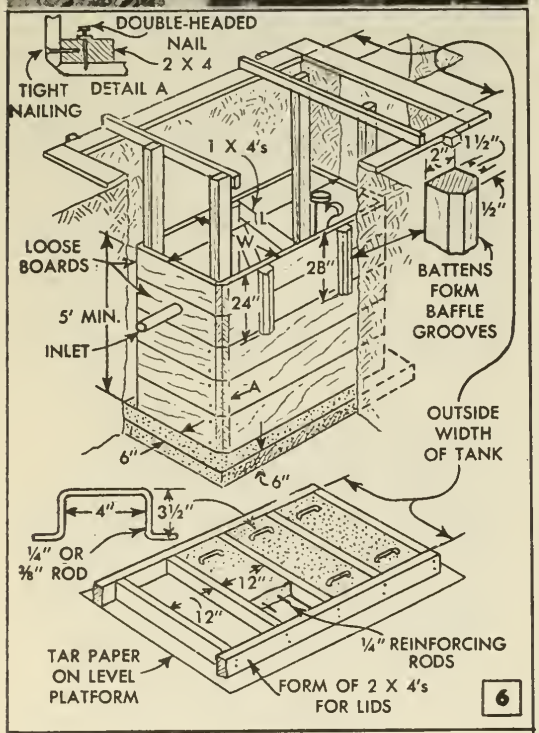

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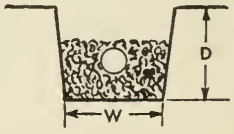
with 12 to 18 in. of earth, at which depth the inlet will be about 30 in. deep. The tank can be located any reasonable distance up to within 10 ft. of the house.

Building concrete tanks: Where the earth is firm, no outside forms are needed. Inside forms are "hung" in place as in Figs. 5 and 6. Use a 1:2¼:2 mix of portland cement, sand and gravel respectively, by volume, with just enough water added to produce a workable consistency. The tank lids are cast in a mold on a level surface. They are reinforced and provided with handles.

House drain and sewer: The house drain should extend at least 5 ft. outside the foundation wall and, as a rule, cannot be installed under a basement floor. Basement waste must be raised to the house-drain level with a sump pump. The house sewer runs from the house to the septic tank. It can be any type of good sewer pipe. The joints should be permanently tight to prevent leakage or the entrance of tree roots. If vitrified-clay pipe is used, pour the joints with special elastic joint compound. Usually, a 6-in. house drain is preferred; 4 in. is the minimum size. Cast-iron pipe is most resistant to crushing and should be used if the lines run under a driveway at a depth of less than 3 ft. The line should be straight as possible, with a slope of ⅛ in. per ft. for 5 or 6-in. pipe, and ¼ in. per ft. for 4-in. pipe. The line from the septic tank to the disposal field should have the same slope. If the tank is over 20 ft. from the house it is advisable to have a cleanout within 5 ft. of the tank.

Size of disposal field: The area required for the field is determined by percolation tests, Fig. 7. Do not make the tests in filled or frozen ground, and if rock formations are encountered, obtain the advice of the State Board of Health. To make percolation tests, dig a number of holes with a posthole auger about 18 to 24 in. deep. Fill them with water until it seeps away at a uniform rate. Then check the time for a known



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depth of water to seep away and divide this by the depth in inches to get the average seepage time per inch. Refer to Table B, which gives the absorption area (area of the trench bottom) needed for the number of persons to be served by the system. Next, refer to Table C to obtain the length and width of disposal trenches and to figure the length of pipe required. For example, if the seepage is 10 min. per in., a family

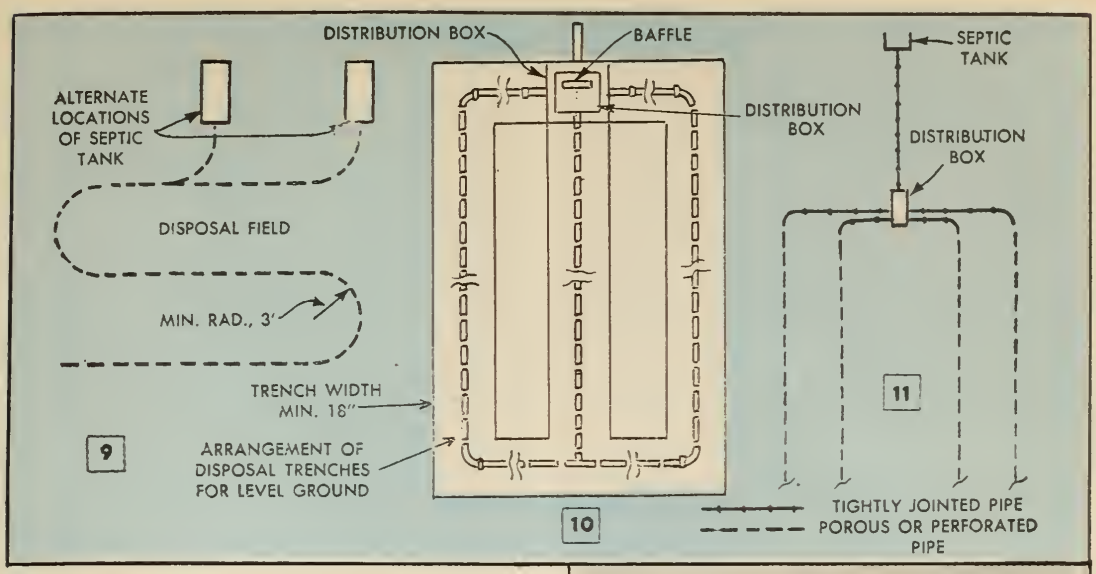


Table A

SIZES FOR SINGLE-CHAMBER CONCRETE SEPTIC TANKS

Persons served	Inside dimensions in feet			Working capacity (gals.)
	Length	Width	Depth	
4 or less	6	3	5	500
6	7	3	5	600
8	7½	3½	5	750
10	8½	3½	5	900
12	8½	4	5½	1100
14	9	4	5½	1200
16	10	4½	5½	1500

Recommended thickness of walls, 6 in.

Table B

ABSORPTION AREA AT BOTTOM OF DISPOSAL TRENCHES REQUIRED PER PERSON SERVED AS BASED ON PERCOLATION TESTS

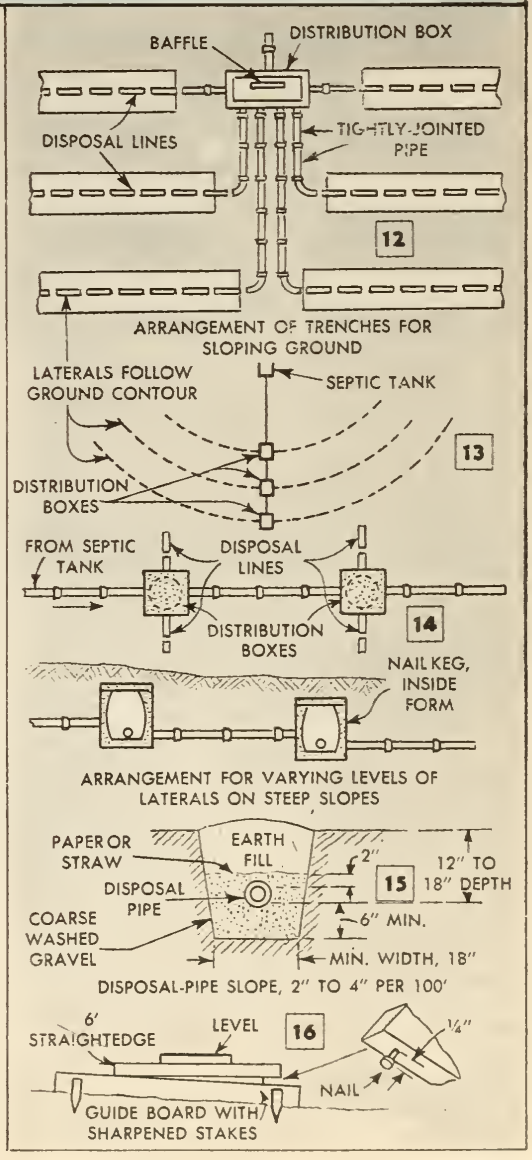
Time of 1-in. seepage from test holes (minutes)	Absorption area per person (sq. ft.)
2 or less	26
3	30
4	36
5	40
10	52
15	63
30	90
60	120

Table C

CONVERSION OF ABSORPTION AREA TO LINEAL FEET LENGTH OF TRENCHES OF VARYING WIDTHS AND DEPTHS

Trench dimensions (in.)		Absorption area per lineal ft.
Width W in Fig. 8	Depth D In Fig. 8	
18	18 to 30	1.5
24	18 to 30	2.0
30	18 to 36	2.5
36	24 to 36	3.0

Spacing between trenches should be three times their width and not less than 6 ft.



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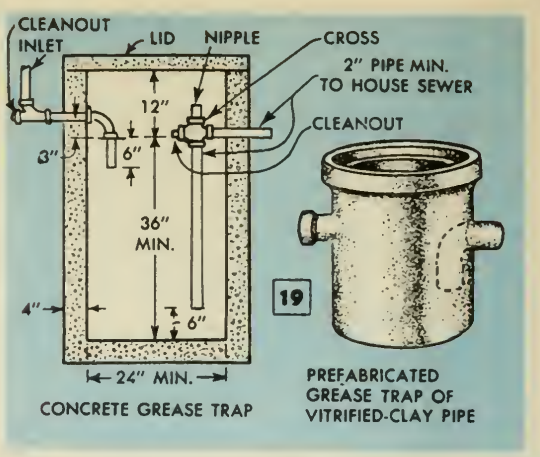


of five will require 250 sq. ft. of absorption area. Divide this by 1.5 (Table C) which gives a trench length of 173 ft. for the 18-in. width.

The disposal field should not be less than 150 sq. ft. of absorption and the lines should not be longer than 100 ft. Spacing between parallel lines should be 3 times their trench width, but not less than 6 ft. Tightly jointed pipe is used from the septic tank to the distribution box, and from the latter to the inlet end of the line.

Disposal-field design: A single line for a small system can be S-shaped as in Fig. 9. Where the ground slopes, the laterals are placed at progressively lower levels. If a line must be longer than 100 ft., use several short ones equaling the total length requirement. Two multiple-line arrangements for level ground are shown in Figs. 10 and 11. Other arrangements for sloping ground, where the laterals follow ground contour, are shown in Figs. 12 and 13. Any multiple-line system requires a distribution box. Sometimes each pair of lines is fed from a separate distribution box, as in Figs. 13 and 14.

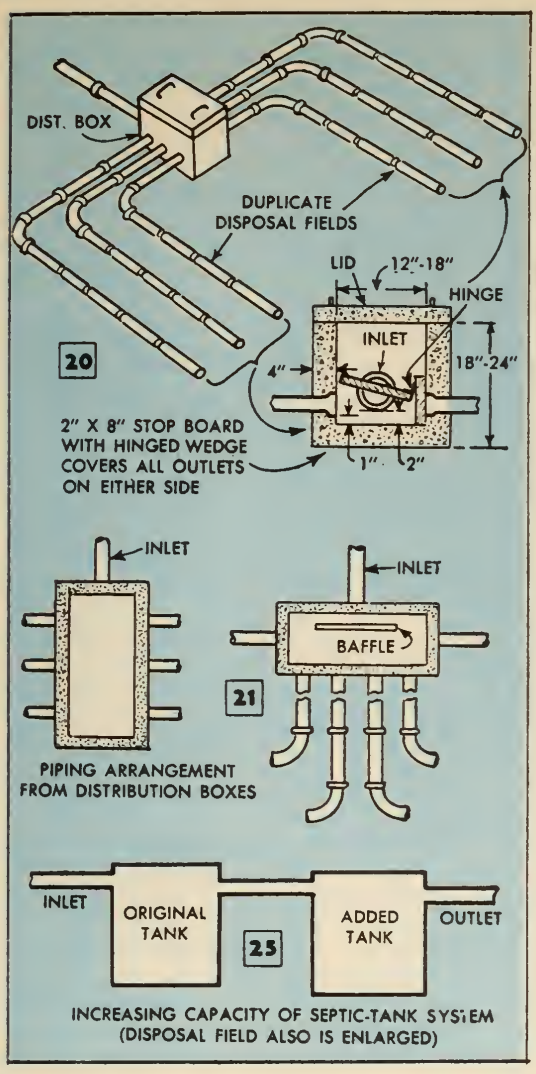
The best depth for disposal lines is 12 to 18 in. below the ground surface, but no more than 36 in. Drainage slope of the lines should be from 2 to 4 in. per 100 ft., but not over 6 in. per 100 ft. Trenches should not be less than 18 in. wide at the bottom. A 6-in. layer of coarse, washed gravel (½ to 2½-in. dia.) is required under the pipe, and a 2-in. layer over it.

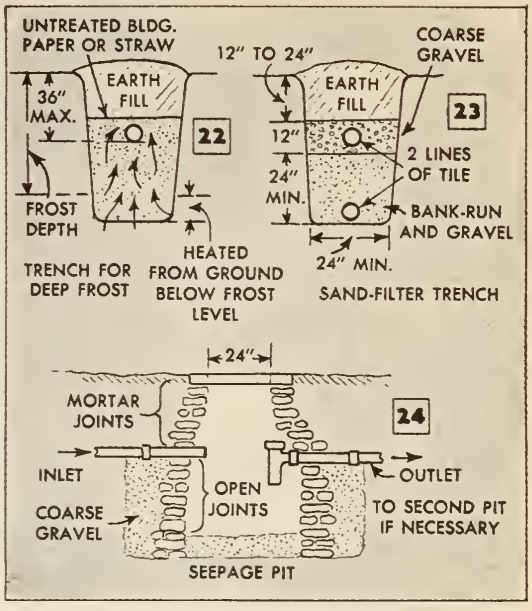
Laying disposal lines: Pipe is laid to grade with a level and straightedge on guide boards, Figs. 16 and 17. The guide boards have pointed stakes nailed to them and are left permanently in place. The nail projecting from the straightedge assures getting the required slope. Drain tile is spaced from ¼ to ½ in. at the joints, which are covered with tar paper, as in Fig. 18. Before filling the trench, the gravel layer is covered with untreated building paper, several layers of newspapers or 2 in. of straw. Where frost penetrates 5 or 6 ft., trenches are dug deeper than this, Fig. 22, and are filled with coarse gravel so that the pipe can be laid to a depth of 36 in.

Distribution boxes: Distribution boxes, Figs. 20 and 21, assure an equal distribution of the effluent to the disposal lines. A baffle is used to stop sudden surges of incoming effluent. Where a duplicate disposal field is used, Fig. 20, a stop board in the distribution box permits shutting off either field for rest or repair.

Disposal lines in tight soils: Where soils are too tight for rapid absorption (as indicated when 1-in. seepage requires 60 min. or more by percolation test) you can substitute sand-filter trenches, seepage pits or other approved means of disposal. Filter-trench construction is shown in Fig. 23. Where the surface soil is tight but is underlain with porous soil, one or more seepage pits, Fig. 24, may be used instead of disposal lines. The distance between pits should not be less than 3 times their diameter and the capacity of the pit should be no less than that of a septic tank.

Grease traps and garbage grinders: A grease trap, Fig. 19, is only needed when there is an abnormal amount of grease and





fat present in the sewage, as on a farm where considerable processing of meat and dairy products is done. However, some states require the installation of grease traps in individual disposal systems. Where one is used, an electric garbage grinder should not be installed in the kitchen waste line. Where a grease trap is not used and a garbage grinder is installed, the septic tank should be enlarged 50 percent.

Storm water and chemicals: Rainwater from roofs should not be led to a septic tank. Only normal quantities of laundry wastes should be admitted. Soap, drain solvents and other mild cleaning and disinfecting solutions will not cause trouble. However, constant disinfected wastes from sickrooms, milk rooms, strong chemicals for sterilizing equipment, pickle brine, photographic chemicals and waste from filters or water softeners should not be admitted to a septic tank.

Care and maintenance: Inspect the tank every 12 to 18 months. Cleaning is necessary when the space for liquids between the sludge and scum is reduced to one half of the total tank depth. In small tanks, this usually takes 2 to 3 years. Larger tanks and two-chambered tanks may go 10 or 12 years before cleaning. The removed sewage has disease-producing germs and should not be used as fertilizer. It should be buried in pits and covered with an 18 to 24-in. layer of earth, at points remote from water sources. Never use any kind of open flame in a septic tank, as the gases in it often are explosive. They also may be poisonous and asphyxiating, so the tank should be ventilated thoroughly before you enter it. When it is necessary to enlarge a system, a second tank can be connected to the original one, Fig. 25, and the length of the disposal lines increased proportionately. ★ ★ ★

Decorate with HARDWOOD PLYWOOD

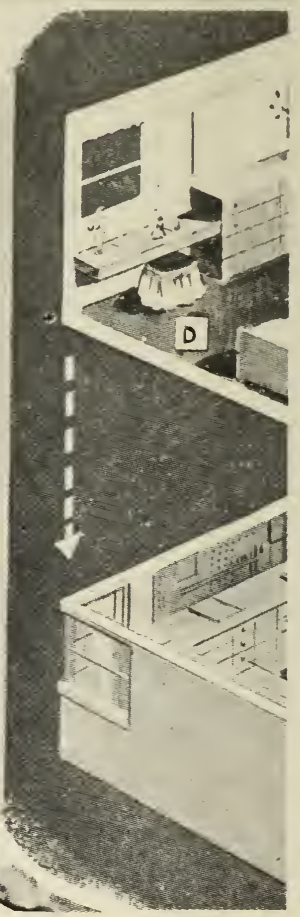
ALL THE SOFT richness and beauty of walls paneled in hardwoods are well within the means of any homeowner, even owners of the lowest-cost homes. The many beautifully grained woods available in the form of large panels of hardwood plywood offer a wide choice, such as mahogany, walnut, oak, birch, cherry, and bring installation well within the ability of the average homeowner.

The advantages of wood paneling are many. It lasts indefinitely, withstands scuffing and is easy to maintain, requiring in most cases only an occasional dusting and an annual waxing. Also, it works well into wall built-ins, the number and kind being limited only by good design and the desires of the owner.

To prove that any homeowner can install hardwood paneling, *Popular Mechanics,* in collaboration with the Hardwood Plywood Institute, commissioned an inexperienced homeowner to panel his home. The results are shown on these pages. Referring to the exploded view shown at the right, the home was a medium-low-cost trilevel comprising a living room, A; kitchen, F; and two bedrooms, D and E, with an unfinished attic. During the paneling operation, the attic was finished to provide two additional bedrooms, B and C, bedroom E being converted to a den.

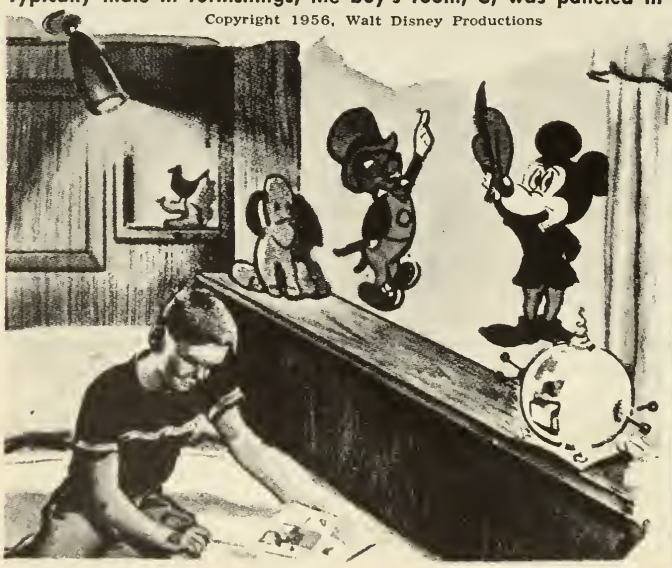
In the living room and in the dining area of the kitchen, Honduras mahogany was used, applying it to one wall on which a plate rack was installed and a door faced with plywood. In the living room, two walls and an open stairwell were paneled, plus a built-in planter-divider island at the front entrance. The original wooden rail on the stairwell gave way to a built-in cabinet with indirect lighting.

The two rooms created in the attic, one for a boy, was paneled in walnut, and one for a girl, was paneled in birch. The converted room that became a den was paneled in oak,



Typically male in furnishings, the boy's room, C, was paneled in walnut

Copyright 1956, Walt Disney Productions



Above view shows how wood paneling makes low-cost home take on expensive appearance

and the master bedroom was done in quilted maple. To complete the house, a "family room" in the basement will be paneled in ash.

The plywood may be used as plain panels or it may be grooved. Grooving serves a three-fold purpose: It relieves the unbroken expanse of wall, simulates random-width planking and, more important, allows unobtrusive joints between sheets.

Grooving is best done with a hand router by placing the plywood face up on a flat surface. With a pencil mark the locations of the grooves at each end of the sheet. Bear in mind that grooves always run with the grain, never against it.

Then, using a straightedge (an 8-foot length of 1 x 4 will do), align corresponding pencil marks, allowing for the distance between the point of the bit and the outside edge of the router plate. Secure the straightedge and run the groove.

The actual grooves should be about $\frac{1}{20}$ in. deep. This depth will penetrate the

The warmth of maple paneling plus well-designed built-ins give room C an irresistible feminine appeal

veneer to the next layer of wood, but the finishing process will subdue the difference in coloring to the point where the grooves will be properly emphasized.

Grooving Process Simple

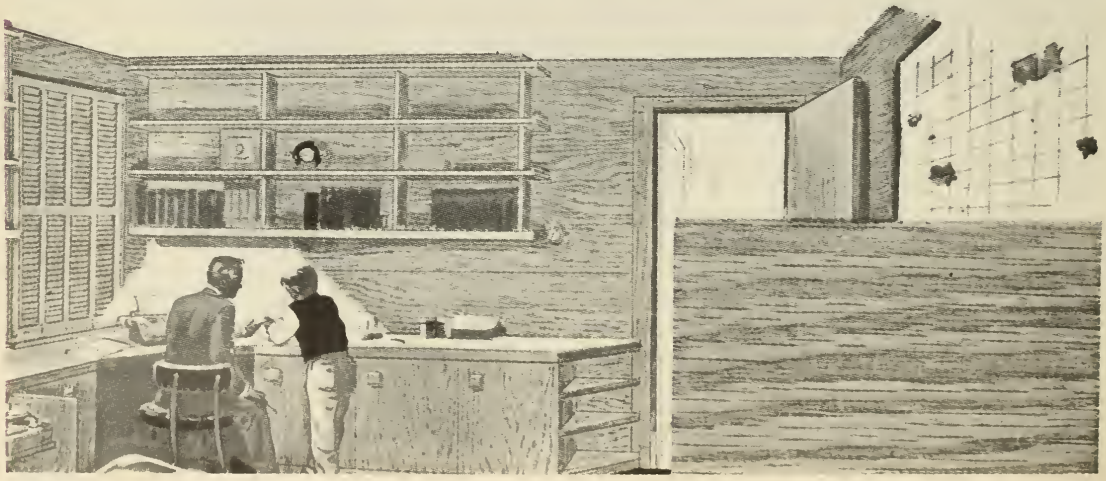
While the grooving operation is not difficult, be careful that the straightedge does not lift from the plywood and allow the router to slide under it. Also, when putting a half-groove, or bevel, on the edges of each plywood sheet for joining to the next one, use a special bit or, as was done here, use a plane.

The actual widths for the random-width effect are not critical, but it is best to observe a minimum of 3 in., 4 in. being preferred. If you use the accepted spacing of the grooves (6-4-6-10-6-8-8) you will find that a groove will cover a stud for nailing if the studs are 16-in. on center. However, in the method of application used here it was not necessary to consider the studs.

Two Ways of Applying

There are two major methods of application — nailing directly through to the studding, or using one of the new adhesives now available and applying the paneling directly to the plastered walls. For this job Rolltite mastic was used. There are two ways of spreading the adhesive, either by "butterballing," as shown page 1773, or with a notched trowel furnished with the mastic. Either method is satisfactory. However, care must be taken to provide a firm

Strictly masculine, den E is done in oak and provided with built-ins to suit the desires of almost any man



Plywood applied with adhesive which is put on wall and panel pressed against it and snugged with hammer

bond between the back of the paneling and the adhesive long enough for it to set.

Shore Up When Possible

Setting time can be found on the label and, where not in the way of family activities, it is wise to shore up pressure against the paneling with 2x4s. The method shown, tapping with a hammer and piece of scrap lumber, will be found adequate in most instances.

Fit Panels to Walls First

Fit your panels first, accurately cut, before you spread the mastic. While this type of adhesive allows the home craftsman much more latitude than does the contact type, it still is advisable to press the panels into place as soon after applying the adhesive as possible.

If you install built-ins, such as the planter island and the book shelves shown, plan the wiring and other features, such as the copper planting box. Then, as you build up the unit, these features will fall into the plan easily. Indirect lighting makes a dramatic showing of your plantings, illuminates the shelves below as well as the poles and also serves as a night light.

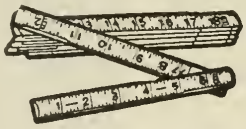
Use Millwork to Match

The usual pine molding should be replaced with molding to match the type of wood in the paneling. In paneling the walls of a stairwell, a problem may arise in that it is not easy to replace the portion of the stair stringer. The illustration at the bottom of this page shows one treatment of this problem.

Also, in paneling stairwells, you will find that the standard 4x8 sheet of plywood will not be long enough. As shown in the center illustration on this page, turn the grain for this treatment.

While any of the fine-grain hardwood plywoods makes a vast improvement in any room, there are other touches that emphasize the paneling and also have a very utilitarian purpose. One of these touches is the wrought-iron handrail available from Tennessee Fabricating Company. It not only steadies footsteps on a stairway, it serves to keep hand marks off the walls.

Above, hand rail adds safety factor, plus decor, to stairwell paneling. Grain direction is changed from vertical to horizontal to make use of standard size sheets of plywood. Below, treatment of mahogany molding around painted stringer and wall



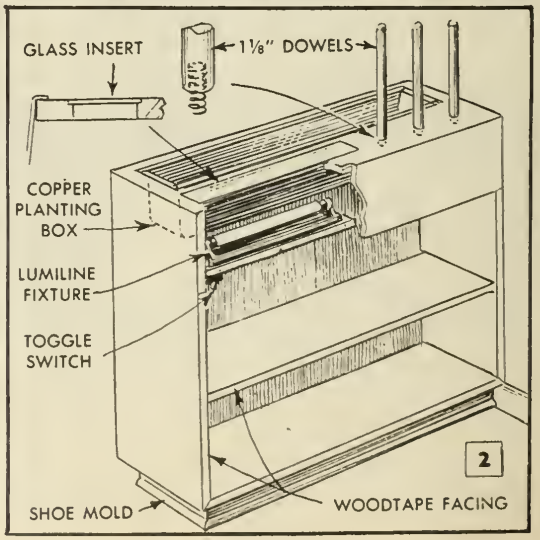
WHILE THE USE of hardwood-plywood panels on the walls alone will provide beauty and warmth for any room, the use of suitable built-ins will add much to the interest and practicability of a room.

For instance, the use of a planter-island, as above, gives the effect of a small entry hall without taking any apparent space from the room. The use of indirect lighting adds a dramatic touch to the plantings, the ceiling and down onto the books.

The planter was built completely from

Drill holes for dowels in planter top for snug fit, making sure to drill only halfway through plywood

Cutaway drawing shows relation of various parts of planter. Toe space at base prevents marring of finish



¾-in. plywood, faced two sides. The base consists of a frame of 4-in.-wide plywood, mitered at the corners so that the plywood stands on edge. This is fastened to the regular flooring with screws and glue blocks, after which a shoe mold is added. Make the base frame about five inches less in over-all size than the unit for toe space.

Then, carefully cutting all pieces of the planter to size, miter all butting edges. This allows them to be joined without the end grain showing. However, on the edges of the open book shelves, covering the end grain can be done, as here, by the use of Woodtape. Easily applied, photo 5, this product provides a simple answer to the problem of covering end grain.

When assembled, make a cutout in the top for a copper planting box. In this instance, the depth of the box is 8 in.; length and width will vary with your plan. The local sheet-metal shop will make the box if you have no facilities. Instruct them to put a 1-in. lip around it as this becomes the sole support.

The Lumiline fixture is mounted on a suitable shelf, screwed to the inside of the planter, beneath which is placed the toggle switch. Placing the switch as shown in drawing 2 keeps it handy yet unobtrusive. For the glass insert over the light fixture, use translucent diffusing glass. Do not use clear glass. Rabbet the top of the planter to take the glass flush.

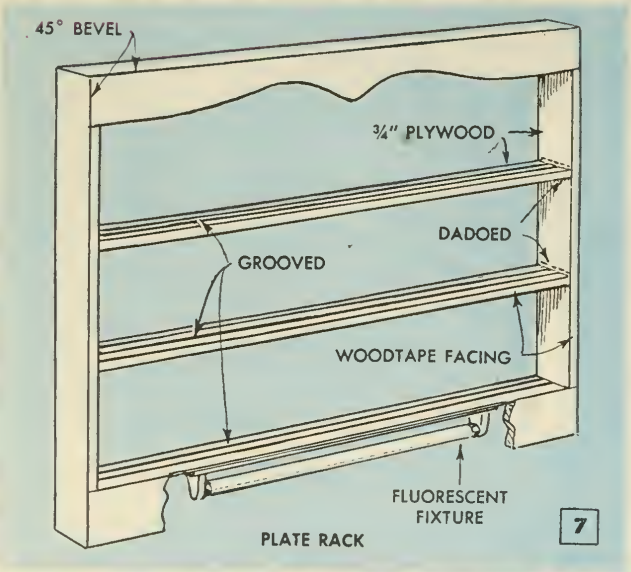
When installing the large dowels that reach from the planter top to the ceiling, drill blind holes just large enough to take them with a snug fit, photo 1. Cut the dowels ⅛ in. longer than the actual distance from the top of the planter to the ceiling. Then drill a hole in one end of each pole and insert a spring, as shown in Fig. 2. This feature has several advantages in that it

Although hardwood plywood has smooth surface, sand lightly before finishing. Sand the millwork, also

Running the grooves is simple task, but care must be exercised to keep grooves straight, correct depth

Occasionally grooves may be fuzzy. Sand lightly with block wrapped in sandpaper, held at 45-deg. angle

When necessary to leave plywood edge exposed, cover grain ends with Woodtape applied with special solvent



solves the problem of how to affix the ceiling ends of the poles, plus the very good feature of easing any future painting of the ceiling. The poles can be removed quickly at any time, and yet the springs hold them firmly in place.

The grooving operation explained in photo 4 should be done with care to produce straight and even lines. Occasionally a groove will be fuzzy on its inner slopes. Sand lightly with fine-grit paper wrapped around a block of wood.

Construction of the plate rail, Fig. 7, is similar to that of the planter. The depth of the unit is four inches and, in this case, the shelves were dadoed into the sides. As with the planter, plan and install your wiring beforehand.

Hardwood plywood, while beautiful in its natural state, is enhanced by proper finishing. Preparation of the plywood for finishing is accomplished with light sanding and thoroughly removing all dust. Then, using cheesecloth or other lintfree cloth, wipe on a stain (in this application, a chartreuse stain was applied to remove the red coloring of the mahogany). Wipe the stain *with* the grain. As soon as the stain "takes," wipe surface clean before starting a new section. It is advisable to experiment on a scrap piece of the paneling to make certain you have the color desired.

Finishing operations, photos 8 and 9, start with stain of desired color, wiped with the grain then filler wiped against grain, allowing ample drying time. Final finish ends up as satiny smooth luster

"Working end" of den has typewriter and file drawers within easy reach under ample desk-counter top

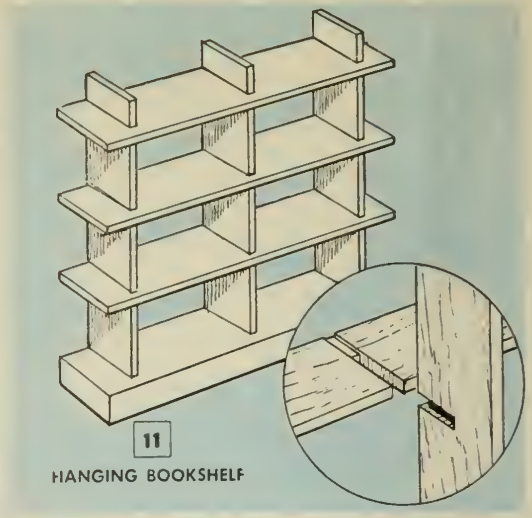
When decorating your home with plywood, an effective treatment of the den or study is a wall covering of flat-sliced oak. The fine, distinctive grain creates an atmosphere conducive to quiet reading or study.

Here the grain of the plywood was run horizontally instead of vertically to make the room appear larger. Except for the meeting edges (which were beveled), these

"Relaxation corner" of teen-age girl's room contains record player and radio as well as handy bookshelves

Dressing-study corner has large desk, built-in drawers and walk-in cedar-lined closet and blanket storage

Accurate cutting of shelves allows a snug fit and assembly to integrated unit without nails or glue



HANGING BOOKSHELF

After assembling hangers as below, draw all fasteners tight. Make sure all threaded rods are vertical

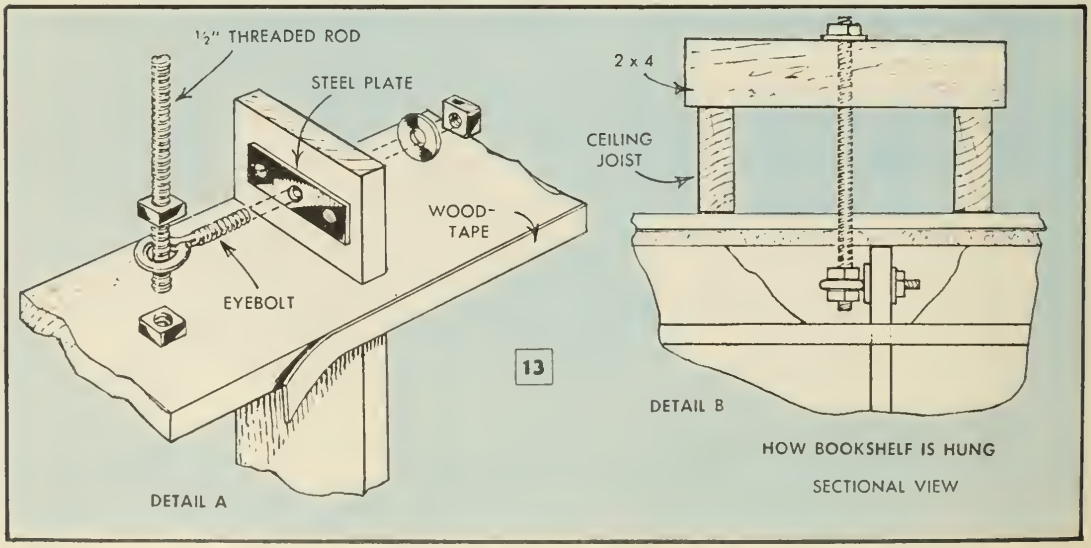
panels were not grooved as were the mahogany panels in the living room. The built-in features of the den (bookshelves, wall map and large desk) relieve the plainness of the unbroken wall panels.

The counter top, which extends 9 ft. along one wall and 10 ft. along another, is 30 in. deep—deep enough to cover cabinets for hi-fi components with ample record storage, typewriter swing-out unit, file drawers, plus 12 other drawers for the many items desired in a "working study."

Hanging the Bookshelves

While the counter, drawers and cabinets are of standard assembly, the bookshelf units, because of their weight, presented a mounting problem. This was solved by suspending them from the ceiling joists.

Built of ¾-in. hardwood plywood in egg-crate construction, Figs. 10 and 11, the shelf units were suspended with hangers made from stock items from the local hard-



Closet wall, rear, has extra door above bed for access. Door holds socks and handkerchiefs on back

ware store. Figs. 12 and 13 show how steel mending plates were bolted to both sides of the vertical members of the units to take an eyebolt drawn up tight. Then a ½-in. threaded rod was affixed as shown in Figs. 12 and 13.

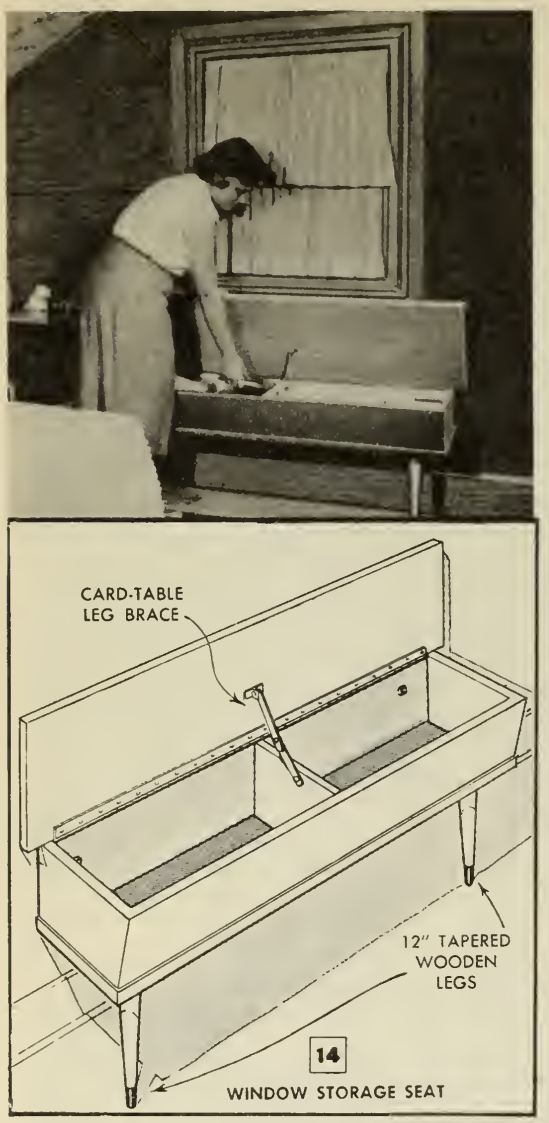
At this point, raise the bookshelf so that the rod ends touch the ceiling. Mark the rod positions and drill through the ceiling for insertion of the rods up through lengths of 2x4s drilled edgewise and long enough to bridge two ceiling joists.

Before raising the shelf unit into place, cut 2x4s to a length that will permit wedging underneath the unit to hold it. When in position, secure it as shown in detail B, Fig. 13.

In the event the floor above is not open, use heavy duty hanger bolts run through the ceiling and into the ceiling joists. Space them accurately so that when the shelf is raised, they will pass through the eyes of the eyebolts. Draw tight with washers and nuts.

Once the shelf unit is firmly in position against the ceiling, the bottom can be fastened against the wall by long finishing nails or wood screws, driving them at an

Simple desk top for five-year-old will have drawer units and other appointments added as need arises



Window seat holds much that is "vitally necessary" to a teen-ager. Brace keeps lid open when desired

angle up from the bottom shelf and into a wall stud.

The bottom shelf can be faced with an apron of ¼-in. plywood, 2 in. wide, to match the paneling. This apron covers the edge of the plywood as well as partially hiding the strip-lighting fixture placed under this shelf to illuminate the counter top. The space between the ceiling and the upper surface of the top shelf can be finished with a soffit cut from matching plywood and glued to the edges of the vertical members of the shelf. The soffit also hides the hangers and keeps dust from collecting in this area.

The shelves are given the final touch, carpenterwise, by covering the end grain with Woodtape, as was shown.

Boy's Room in Walnut

The boy's room was paneled in flat-sliced walnut. The grain of the walnut is vertical, allowing the repetitive pattern to be shown to its best advantage. Built-ins include a desk, combination blackboard and a train board which, as a boy's interests change, can be used as a worktable for hobbies. Both the table, which is hinged to the wall, and the desk are made of ¾-in. hardwood plywood to match the wall paneling.

A money-saving feature in the children's bedrooms was introduced in the use of stock pine trim (base, cove and door trim). The grain will, of course, differ and if, after finishing the trim along with the paneling, you do not like the effect, cover the trim with a paint that will harmonize with or accentuate the paneling.

Space under the eaves was utilized for a cedar-lined closet. To facilitate removal of clothes, especially shirts and short suit coats, a door was built into the wall above the pillow level of the bed (see photo, page 1779). The cabinet-type door has 4-in.-deep shelves on the back to hold handkerchiefs and socks.

Girl's Room in Birch

Birch with its graceful grain was used to panel the room for a teen-age girl. Probably more so than the straight grains of oak and mahogany, the birch lends itself to such feminine built-ins as a vanity, and yet preserves a dignity that appeals to adults.

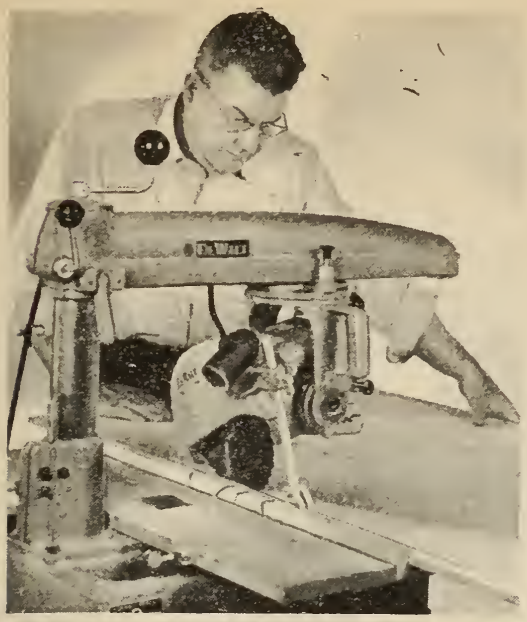
The normal structural features (which should be utilized in any attic remodeling) permitted many built-ins such as a walk-in cedar-lined closet (see page 1777, lower right photo), built-in drawers and a 6-ft.-long desk. Other features include a vanity, bookshelves, storage headboard and window seat, Fig. 14, made of ¾-in. plywood and covered with a cushion.

Hints on Hardwood Plywood

In this article, an attempt has been made to show how hardwood plywood, with many different grains available, can be used by the homeowner to beautify and increase the value of his home.

However, two things should be kept in mind when using these fine woods. First, it is wise to keep all woodworking tools sharp. This is important.

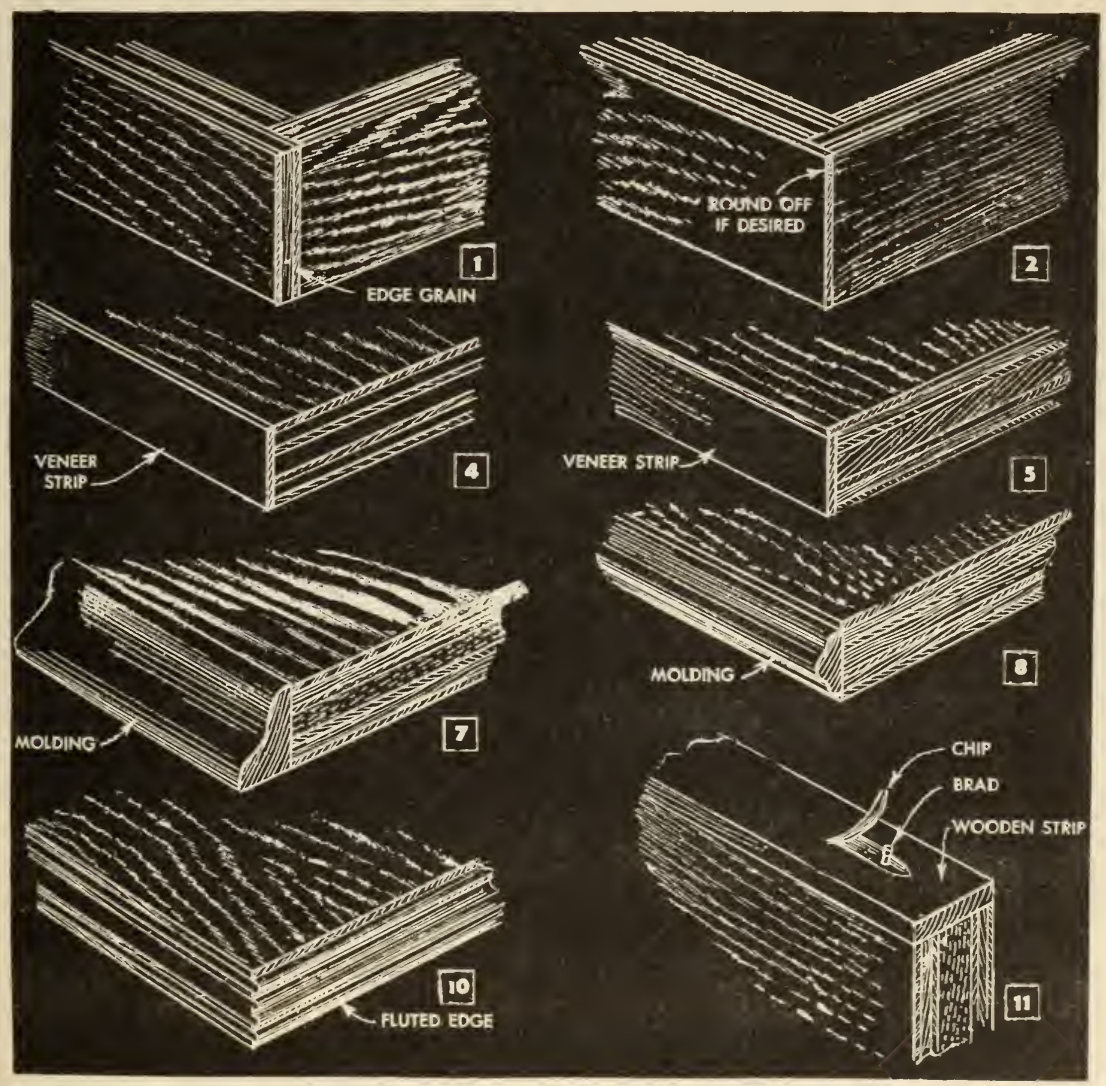
Second, fine woods should have fine finishes. Choose yours with care and apply it according to the manufacturer's instructions. A fine finish will bring out the grains inherent in these plywoods and will provide a surface that requires a minimum of maintenance. ★ ★ ★



HOW TO TREAT PLYWOOD EDGES

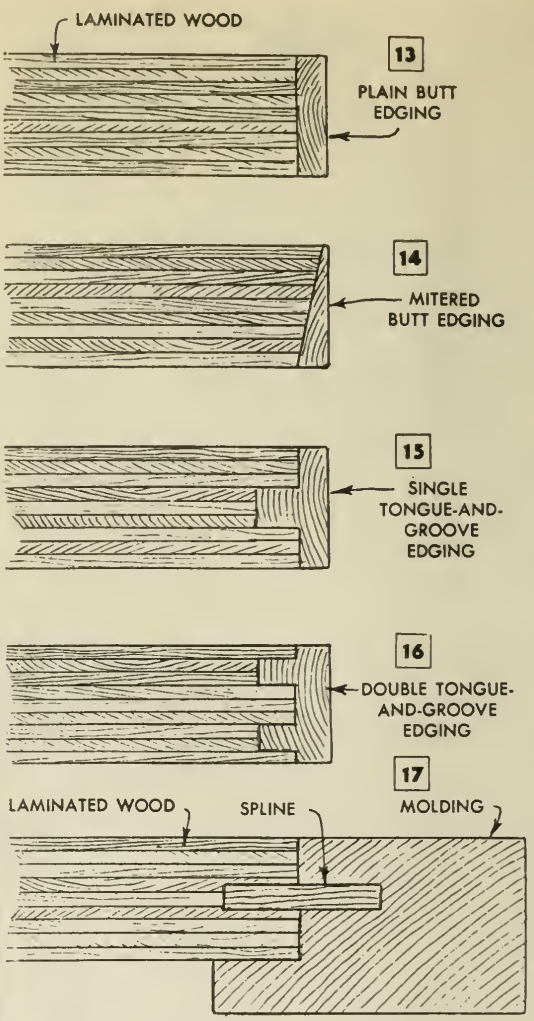
By William B. Eagan

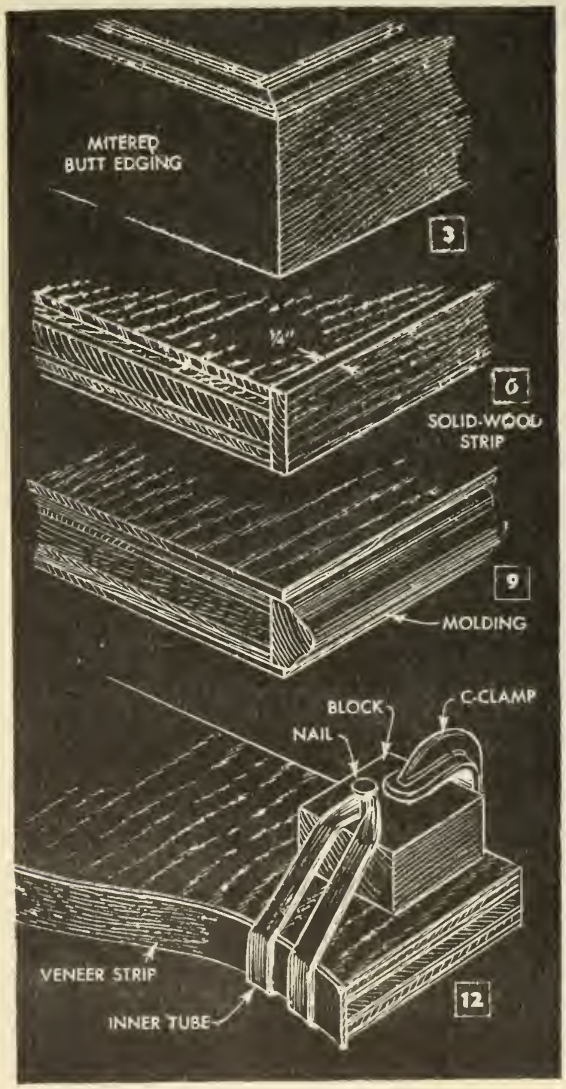
WHILE THE USE of plywood has become universal in both the building and furniture industries, its use in the home shop has always confronted the craftsman with the problem of how to conceal or treat the exposed laminations of the material. The drawings on this and the following two pages illustrate a number of ways that the edges can be covered. Some of the methods are comparatively simple while others are more involved.



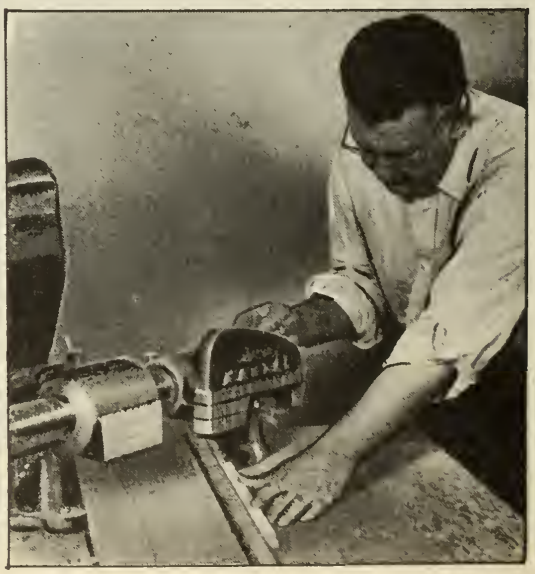
The most common type of drawer joint is shown in Fig. 1, but here the edge grain is exposed and conspicuous. Figs. 2 and 3 show how the same drawer joint can be made so very little or no edge grain is exposed. The amount of edge grain exposed in Fig. 2 may be further reduced and even camouflaged by rounding the corner.

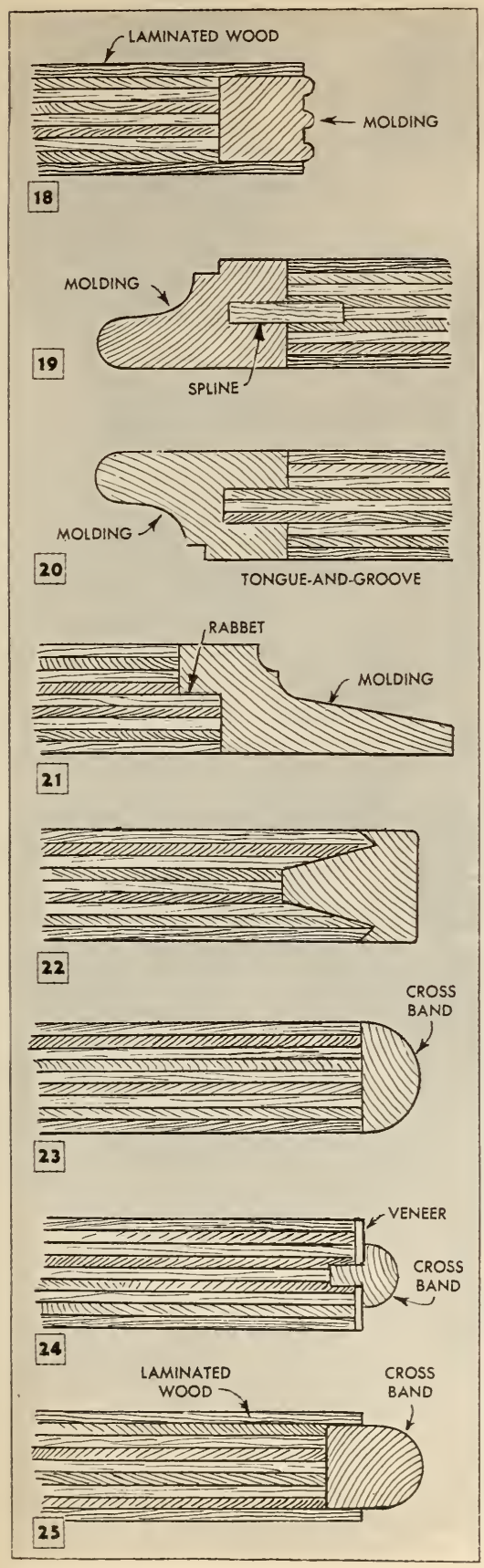
You also have the problem of what to do with plywood edges when the material is used for the shelves in a bookcase or for a table top. The easiest solution is to hide the exposed plies with strips of veneer as shown in Fig. 4. Usually the grain of the veneer is placed lengthwise, but a pleasing variation is had by letting the grain run vertically. In this treatment, often referred to as crossbanding, two plies of veneer produce the best job. This consists of gluing two sheets of veneer together with the grain at right angles and then cutting the edging strips from it. Here, the veneer is brought flush with the top surface of the





Below, left, simple fixture for holding veneer to curved edge while glue dries consists of rubber band hooked over nails in two blocks clamped to each side of work. Strong band is cut from inner tube



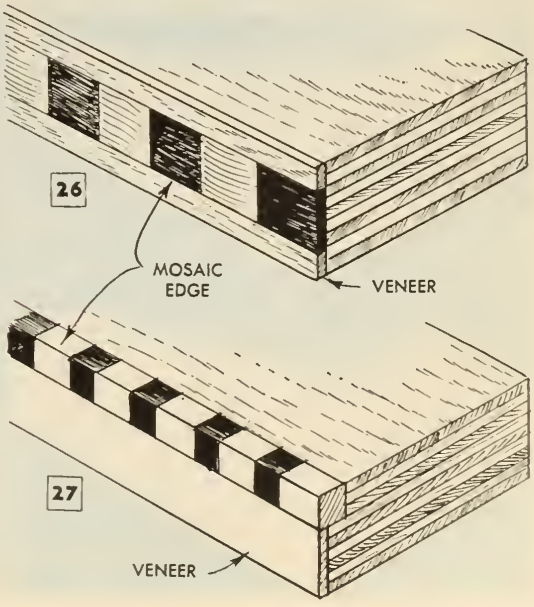


plywood. The objection to having the edge of the veneer show can be overcome by first rabbeting the laminated edge of the plywood as shown in Fig. 5 and letting the top ply overhang the edge of the veneer banding. This latter method also tends to protect the edge of the veneer from wear and damage.

Instead of using thin veneer as in Fig. 4, a ¼-in. strip of matching solid stock may be glued to the edge to hide the plies, Fig. 6. Similar treatment is shown in Figs. 7 and 8 except that stock molding is used. By running a groove in the center of the plywood edge to receive a molding which is narrower than the thickness of the plywood, a variation can be had resulting in a stronger joint, Fig. 9. There are cases where the objectionable plies can be "concealed" without actually adding anything to the edges. Such is the case when a piece of furniture is given a two-tone treatment by painting or staining the plywood edges, or when design permits the edges to be beaded or fluted on a shaper as shown in Fig. 10. Beading should be limited to furniture such as Duncan Phyfe.

In facing the edges with banding or molding, glue alone is not relied on. The stripping is nailed also. Fig. 11 shows how the nailheads are concealed by first lifting a chip with a narrow gouge, driving the brad and then gluing the chip down again. Done properly, the chip seldom can be detected when the final finish is applied to the wood. When veneer is to be applied to a curved plywood edge, Fig. 12 shows a simple method for holding the work until the glue sets.

Figs. 13 to 25 inclusive show additional ways that molding of one kind or another can be used to dress off the edges of plywood. Plain butt edging, Fig. 13, in which



the strip is surface-glued, is the easiest of all to apply. Where it is desirable to reduce the visible thickness of the strip, the mitered butt joint can be used, Fig. 14. Here, the strip is dressed at an angle to match a similar bevel cut in the plywood and simply surface-glued and nailed in place. Splines, Figs. 17 and 19, often are used to give a stronger joint when applying edge moldings. The use of a spline is especially recommended where a wide molding is involved. If molding equipment is available, plain solid stock may be applied to the edges and shaped afterward. The home craftsman will find many stock moldings adaptable. Fig. 22 pictures a joint that perhaps is the strongest of all but one that requires a complicated cut made by a special machine.

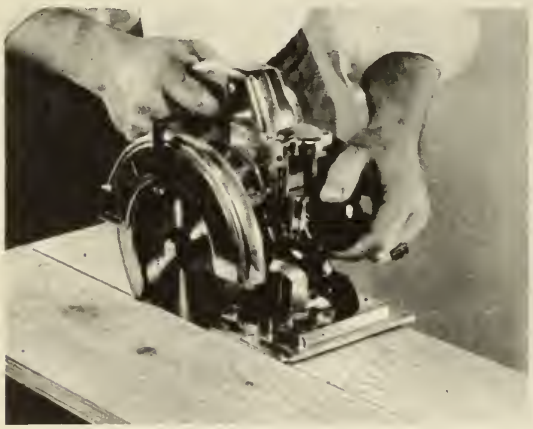
A bold treatment of the plain cross-banded edge is shown in Figs. 26 and 27. Here, inlaid banding is used. A strong contrast is obtained by using rare woods, such as ebony, holly, ivory or boxwood. In Fig. 27, a rabbet is cut along the upper edge of the plywood to take a built-up mosaic strip and veneer covers the rest of the exposed laminations. ★ ★ ★

Finishing Fabricated Panels Made of Plywood Scraps

Home craftsmen probably use more plywood than any other wood and eventually accumulate a sizable stock of remnants. In many cases these leftovers can be used up in a fabricated panel and one of the best ways to hide the built-up core of such panels is with a covering of muslin. The muslin should be of good quality and free from nubs. It is glued smoothly to the surface, and when dry, the pores of the muslin are filled by rubbing in a commercial wood filler. Spackle is inexpensive and quite suitable for this purpose. The filler is carefully sanded with fine paper, taking care not to roughen the threads of the cloth. Then the surface is dusted and painted. When a hard glossy enamel is used, you can build up a durable finish which resists denting, making it ideal for a desk top. If a glossy finish is not desired, it can be toned down by rubbing with pumice and oil.

William B. Rasmussen, Posser, Wash.

Up-and-Down Sawing Leaves Smooth Edge on Plywood



There's a point in good craftsmanship to keep in mind when sawing plywood: the blade on your table saw cuts only when the teeth are going down. But when you use a portable saw the blade cuts going up. When sawing plywood of the grade known as "good one side," place the workpiece on the table saw with the good side up as in the right-hand photo. With the workpiece in this position, the cut will be made with the teeth of the blade going down. Due to the down-cut the corners of the saw kerf on the top side of the workpiece will not be splintered or chipped, even though you use a blade with a wide set. But, when you are cutting plywood with a portable saw, turn the workpiece over with the good side down as in the left-hand photo. The effect is the same as cutting the workpiece with the good side up on the table saw and you get a smooth cut. The blade must be sharp, and on the table saw, the ripping fence must be properly aligned with the blade.

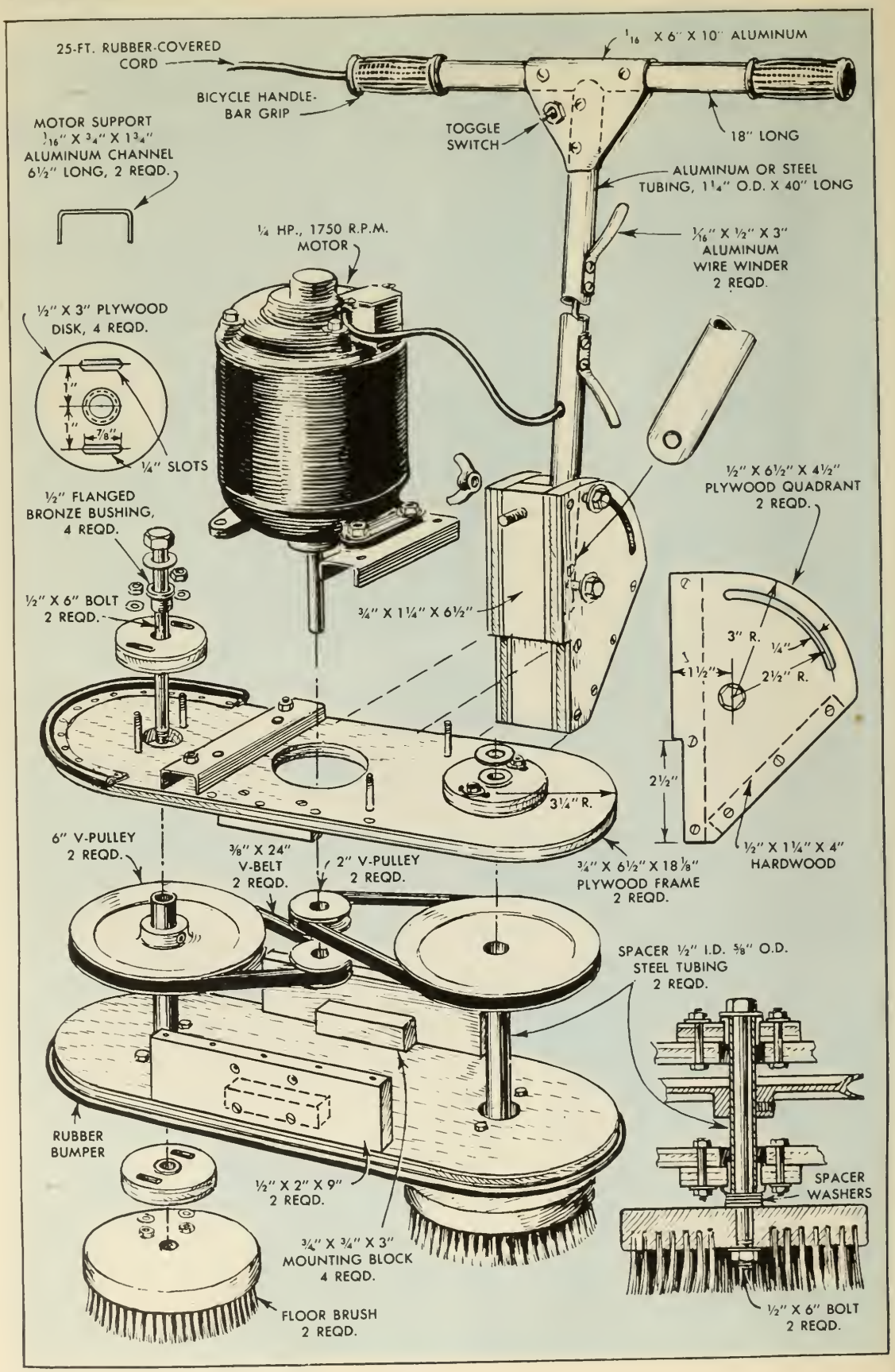
—John A. Comstock

TWIN-BRUSH FLOOR POLISHER

Underside view of polisher. Note rubber bumper tacked to rim to prevent marring

BESIDES SAVING PLENTY of elbow grease in keeping your floors beautifully waxed, this homemade twin-brush floor polisher will save the usual rental fees, plus the inconvenience of carting the machine back and forth, and actually will do a better job of polishing than the common single-brush type. If you already have a ⅛ or ¼-hp. electric motor, the polisher can be made for less than $10.00.

The pullapart drawing on the opposite page shows the main parts that must be purchased, namely, the motor, four V-pulleys, two V-belts, four bronze bushings and two 6-in. circular floor brushes. The bronze bushings used in the original can be purchased for about 60 cents each from a dealer of Boston Gear products. The pulleys are sandwiched between plywood plates which are held 2 in. apart by two spacer blocks screw-fastened to small mounting blocks attached to the plates. Except for the 3-in. hole for the motor shaft, both plates are drilled alike and may be clamped together for boring to assure perfect alignment. The brush spindles are lengths of steel tubing which turn in bronze bushings press-fitted in 3-in. plywood disks. These disks also are slotted for lateral adjustment and are centered over the 1-in. brush-shaft holes. Regular ½-in. machine bolts are used inside the tubing to mount the brushes. The sectional drawing shows how several washers are used to provide clearance between the brushes and the mounting bolts that hold the bushing disks. The motor is mounted in a vertical position on two aluminum rails bolted to the top plate. If your motor has a mounting bracket like that shown in the drawing, it may be bolted directly to the top plate. If your motor is of the conventional type that has the mounting bracket on the side, it still can be mounted on end by using the threaded bolt holes that hold the end housing on the motor. Drill the mounting holes in the rails to align with the holes in the end housing and replace the original bolts with longer ones. If direction of rotation causes the brushes to loosen, simply reverse the position of the leads in the motor to reverse the direction. A sheet-metal guard is tacked to the edges of the plates to enclose the belts and pulleys, and the handle is made as detailed. Note that the top of the handle bracket is held to the motor with a bolt which is turned into a tapped hole in the side of the motor. Sponge-rubber upholstery welting is tacked around the edges of the plates to protect furniture from marring. The motor can be wired to a toggle switch located in the handle.


25-FT. RUBBER-COVERED CORD
BICYCLE HANDLE-BAR GRIP
MOTOR SUPPORT 1/16" X 3/4" X 1 3/4" ALUMINUM CHANNEL 6 1/2" LONG, 2 REQD.
1/16" X 6" X 10" ALUMINUM
TOGGLE SWITCH
18" LONG
ALUMINUM OR STEEL TUBING, 1 1/4" O.D. X 40" LONG
1/16" X 1/2" X 3" ALUMINUM WIRE WINDER 2 REQD.
1/4 HP., 1750 R.P.M. MOTOR
1/2" X 3" PLYWOOD DISK, 4 REQD.
1"
1"
7/8"
1/4" SLOTS
1/2" FLANGED BRONZE BUSHING, 4 REQD.
1/2" X 6" BOLT 2 REQD.
3/4" X 1 1/4" X 6 1/2"
1/2" X 6 1/2" X 4 1/2" PLYWOOD QUADRANT 2 REQD.
3" R.
1/4"
1 1/2"
2 1/2" R.
2 1/2"
3 1/4" R.
6" V-PULLEY 2 REQD.
3/8" X 24" V-BELT 2 REQD.
2" V-PULLEY 2 REQD.
3/4" X 6 1/2" X 18 1/8" PLYWOOD FRAME 2 REQD.
1/2" X 1 1/4" X 4" HARDWOOD
SPACER 1/2" I.D. 5/8" O.D. STEEL TUBING 2 REQD.
RUBBER BUMPER
1/2" X 2" X 9" 2 REQD.
3/4" X 3/4" X 3" MOUNTING BLOCK 4 REQD.
FLOOR BRUSH 2 REQD.
SPACER WASHERS
1/2" X 6" BOLT 2 REQD.

An Easy-to-Build GLASS-FIBER POND

By Boris Volg

NO OTHER FEATURE will add as much natural beauty to your landscaping as a pond, stocked with fish and planted with water lilies and other aquatic plants. Such a pond now can be built in a short time, without heavy labor, and with no tools except a shovel, broom, paintbrush and tin snips. Glass-fiber cloth and polyester resins are the building materials required.

First, dig a shallow excavation the size and shape desired, then wet the dirt and "trowel" it with a broom so it is fairly smooth. Next, lay the cloth in place in the excavation, lapping it over the top edge a couple of inches. Lap all joints 2 in. Mix the resin according to the manufacturer's directions and apply it to the cloth with the paintbrush. Holes and tears in the cloth can be patched with a piece of the cloth and resin. Allow the cloth to dry, then trim the top edge with the tin snips. Paint the cut edge with resin and smooth it over to eliminate any sharp edges.

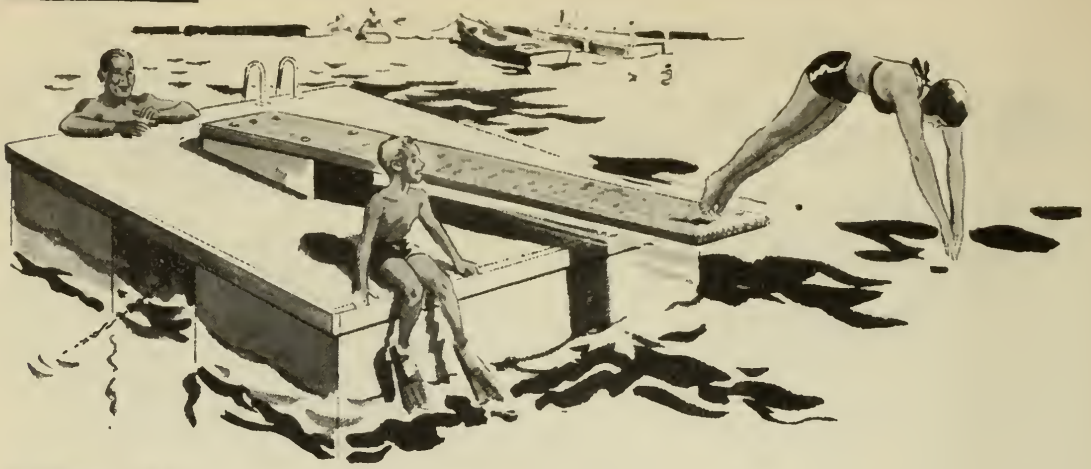
Because the glass-fiber-resin combination is inert, fish and plants can be placed in the pond as soon as it is filled with water.

After hole has been excavated and wet soil smoothed with broom, cut glass-fiber cloth to fit in pond

Use paintbrush and saturate cloth with resin. Patch holes with cloth and resin, allow to dry completely

Trim dried cloth with tin snips, paint edge with resin to eliminate sharp edges. Patch all holes

Ignore sand or dirt stuck in resin, fill pond with water, drop in fish, add flowers and job is done



DIVING FLOAT

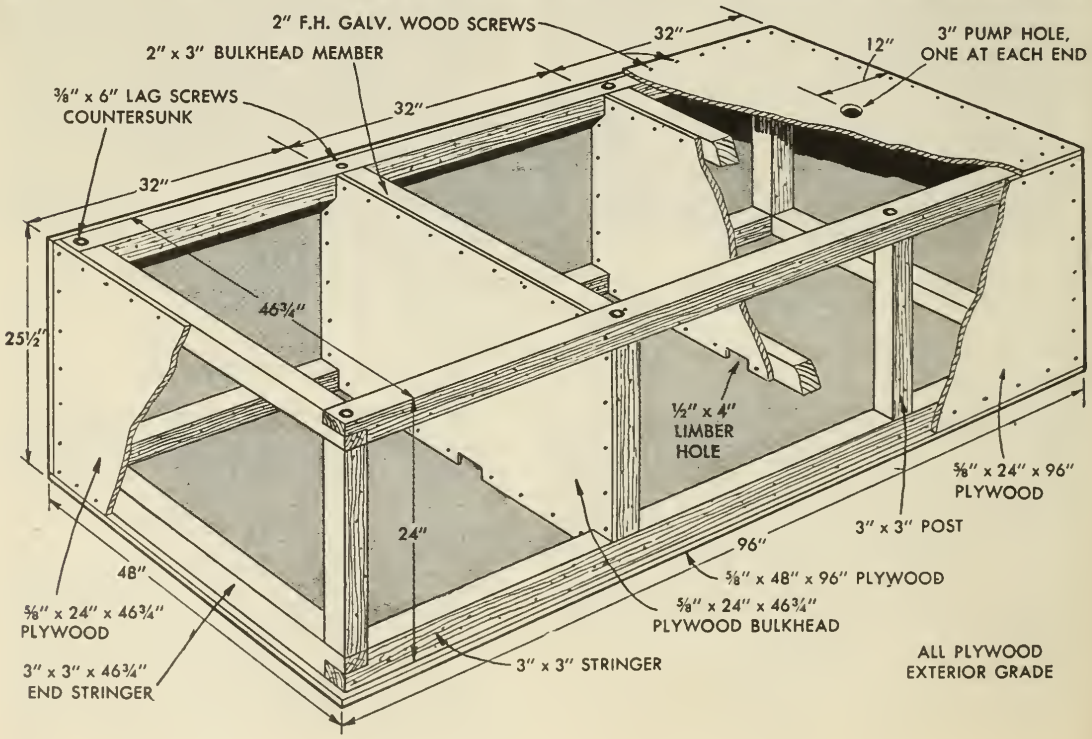
For more enjoyable water sports, build your dock, diving float, launching ramp or boathouse on—

PLYWOOD PONTOONS

INEXPENSIVE, EASY-TO-BUILD pontoons are the answer to your problem if there is need to frequently rebuild a dock or other pile-supported marine facility because changes in the water level have made it unusable. A pontoon, such as the one shown in the drawing, can be used as the basic unit upon which to float the structure desired, such as the ones illustrated.

Two of these pontoons with a platform nailed on top of them provide a diving float. A diving board and other equipment

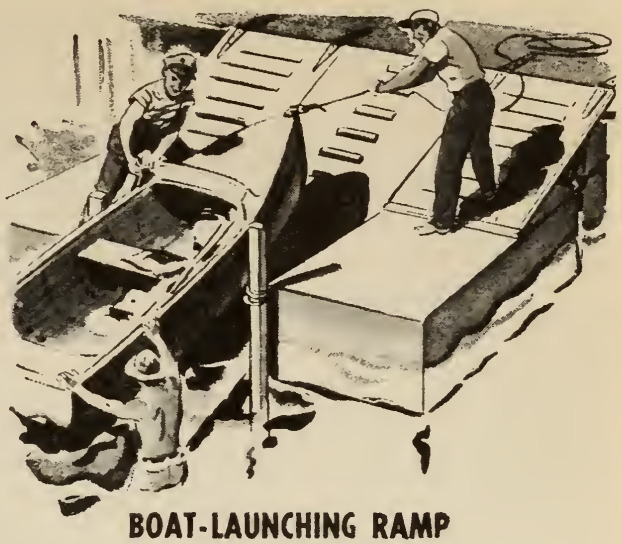
Bosic unit for floating ramp, boathouse, deck and diving float is plywood pontoon 8 ft. long and 4 ft. wide



can be added as necessary. In some cases, as when the pontoons are used for a dock or boat-launching ramp, the ⅝-in.-thick plywood tops serve as a dock. Additional decking is unnecessary.

Maximum buoyancy of one pontoon is 3650 lb. initially, but it can be ballasted with water to gain the desired depth. Only exterior-type fir plywood should be used for the pontoons. Three types of protection may be used to prevent deterioration of the plywood. Pontoons may be pressure-treated with creosote if a pressure-treating plant is located in the vicinity, or they may be covered with glass fiber, although the latter does not give the protection against decay that creosote treatment provides. The third type of protection involves painting the pontoons as you would the hull of a boat, using a good grade of marine paint. A final coat or two of antifouling paint below the water line will discourage marine growths.

A 3-in.-dia. hole cut in the top of each pontoon permits inserting a hand-operated bilge pump, obtainable at most marine-supply stores, for removing water should the pontoon leak. Although some taking on of water is to be expected at first, a well-constructed pontoon will stop leaking soon after it is launched. It is a good idea to paint the inside of the pontoons to reduce water absorption by the plywood. ★ ★ ★



BOAT-LAUNCHING RAMP

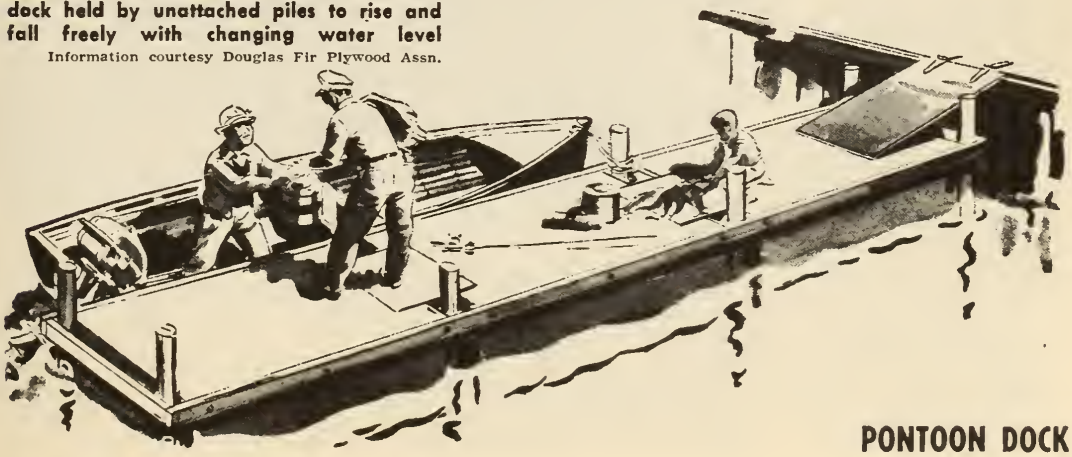
FLOATING BOATHOUSE

Top of page, launching ramp is automatically raised or lowered as water level changes. It is secured to sea wall and two piles

Center, floating boathouse anchored offshore because water is too shallow at landing. Overhead door permits easy entry of boat

Below, 2 x 4s bolted to pontoons permit dock held by unattached piles to rise and fall freely with changing water level

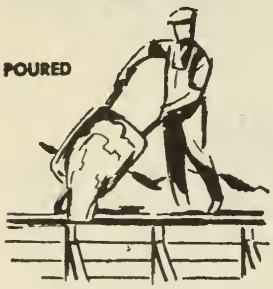
Information courtesy Douglas Fir Plywood Assn.

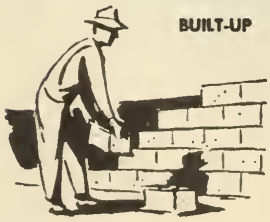


PONTOON DOCK

SWIMMING POOLS—

Luxury free-form pool measures about 16 x 34 ft. Gunited, it costs about $3500 in the Los Angeles area

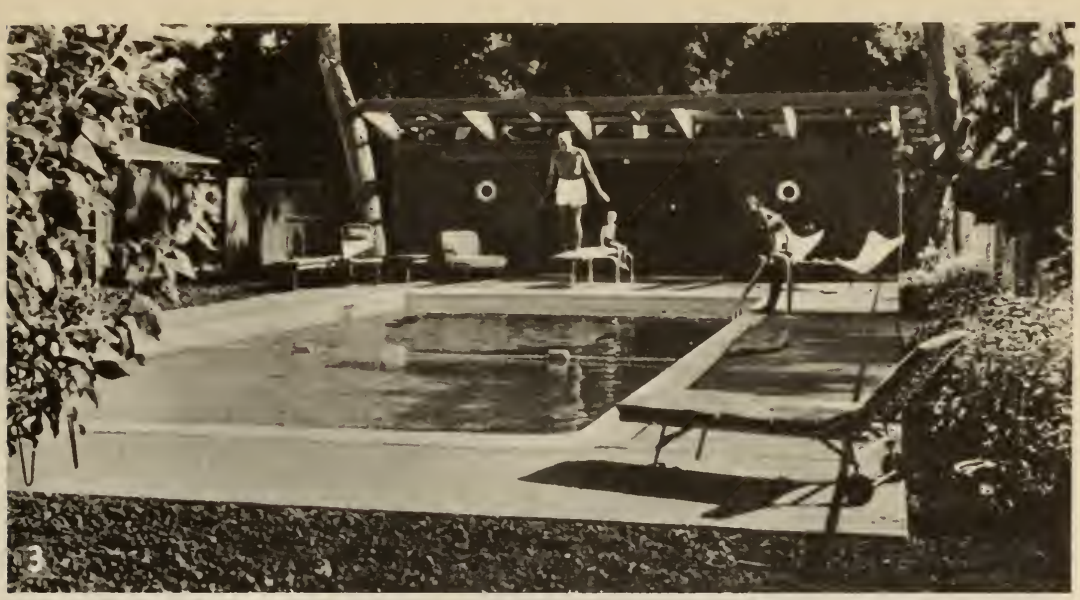




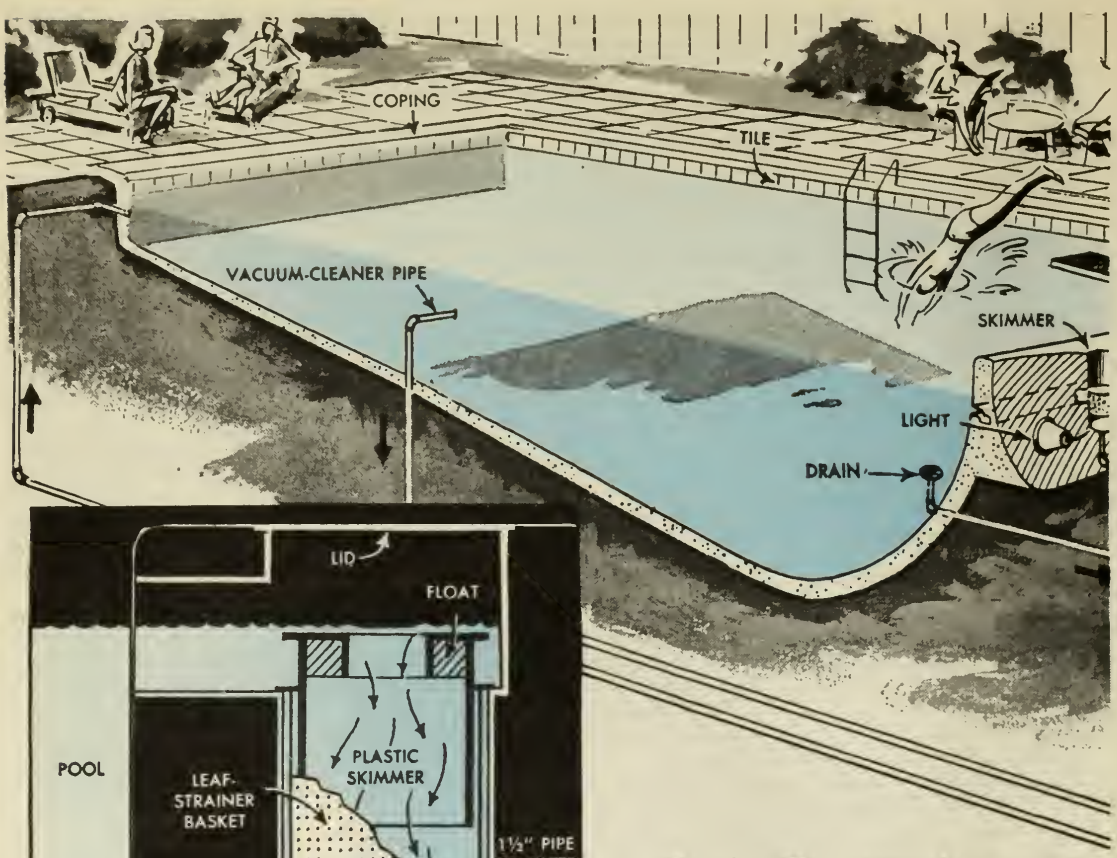
ADDING THE FINAL TOUCH of luxury, a swimming pool, undoubtedly, will be the one facet of modern outdoor living most appreciated by all members of the family. And, while it likely will carry the largest initial cost, it will be the least expensive in the long run as it will increase property value more than its original cost.

Built to various shapes and sizes, swimming pools generally are constructed by one of four methods—Gunited concrete, poured concrete, built up of concrete blocks, and plastic-lined over sand and concrete. In operation they are either the fill-and-draw type or the recirculating type which is pictured in Fig. 6.

Larger Gunited pool in free form but expensive, cabana and all. Pool is made shallow at end in foreground to provide children play area



Above, this 20 x 42-ft. pool has everything — filter, heater, cabana with dressing rooms, even intercom and hi-fi. Left, flagstone coping, rock wall and plantings give this rustic pool a cool mountain-lake look



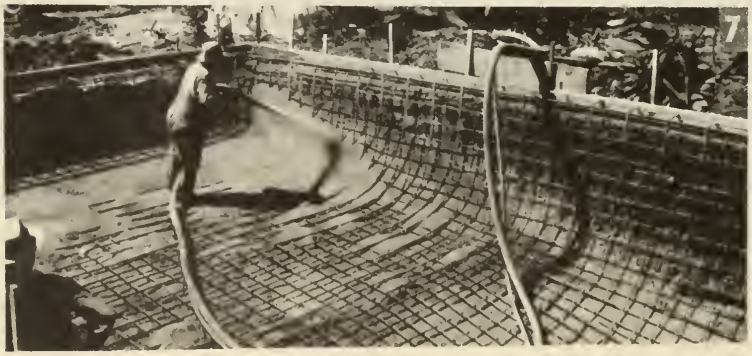
COMPLETELY EQUIPPED SWIMMING POOL 16 x 34 FT.

6

One of the most important things is the location of the pool. The location must comply with local codes on street setbacks and the like, and the site should be where power equipment and trucks can get to it. Any hand digging or wheel barrowing of materials in and earth out will balloon both time and costs. If your landscaping is already in, try to locate the pool where heavy trucks will do a minimum of damage. Avoid filled ground and hard rock, which will increase construction costs considerably.

For swimming, sunbathing, play—for full future usage—place the pool where it will receive maximum sunlight. A sunny pool is always more enjoyable, and the free energy heats the water considerably thus reducing heating bills. Equally important is to place the pool where the house or high fencing and a cabana will protect it from the prevailing winds. A cool breeze reduces the months you can use it and also brings in dust and leaves to increase cleaning time.

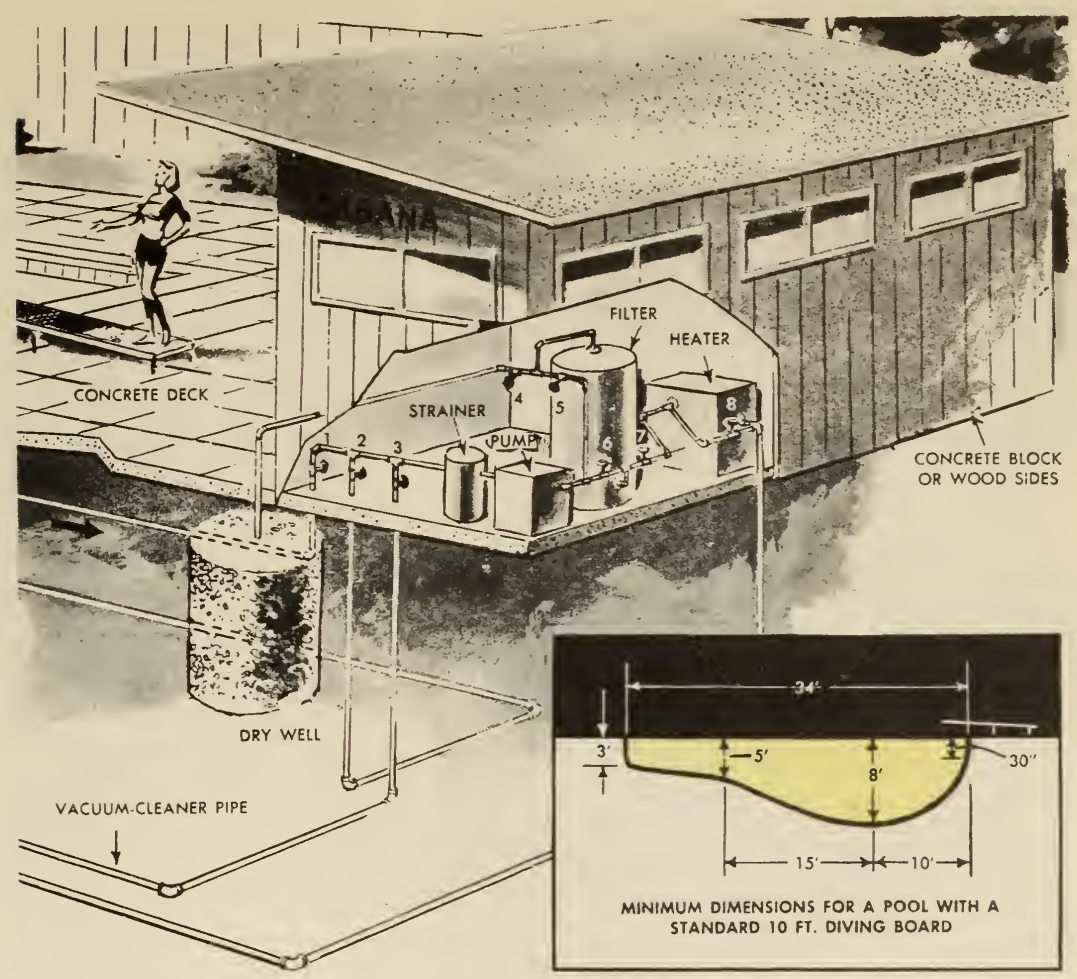
Most trees should be avoided. Any close-by tree which will shed leaves gives a continual pool maintenance problem. The



7

GUNITED POOL

Here the concrete is sprayed rather than poured. Two hoses feed dry-concrete mix and water under pressure to a single nozzle from which mixture is sprayed over framework of reinforcing-rods, wired together and blocked out 2 in. from the earth wall



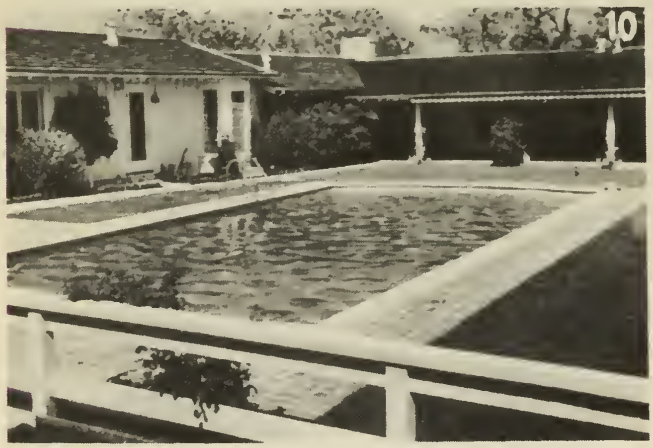
leaves clog skimmers and strainers, and stain plastered pools if left on the bottom any length of time.

Your pool's size is mostly a matter of the budget and the space available, but not all. Figs. 1 through 5 and 9 and 10, show pools of many sizes and shapes. A large pool (20 x 40 ft. or more) will continue to be expensive, can require double the usual monthly costs for chlorination and heating, and considerable more time for cleaning. One 16 x 34 ft. seems most ideal; 75 percent of contractor-built pools today are about this size. Smaller pools without diving boards have proved fully satisfactory.

The minimum pool for a standard 10-ft. diving board placed about 18 in. above the water is the 16 x 34-ft. size, dimensioned as shown in the right-hand detail of Fig. 6. Less depth or length of the deep area can be dangerous. A 1-meter board (one meter above the water) requires at least a 9-ft. depth. A 3-meter board needs a much larger pool with a 10-ft. minimum depth at 15 ft. distance from the deep end and the 5-ft. break 35 ft. from the deep end.

DRY-PACKED POOL
Here pool shell is "plastered" with stiff concrete mix which is packed in place over reinforcing wire with shovel. Note how wood braces keep the stiff mix from sagging on walls. Shell can be rounded as in guniting but must be made extra thick

Without diving board or ladder, this 30-ft. glass-fiber pool costs about $3000 installed in areas close to manufacturer



Being well enclosed, this 20 x 40-ft. pool is easy to maintain. Features precast coping and a non-skid brick decking

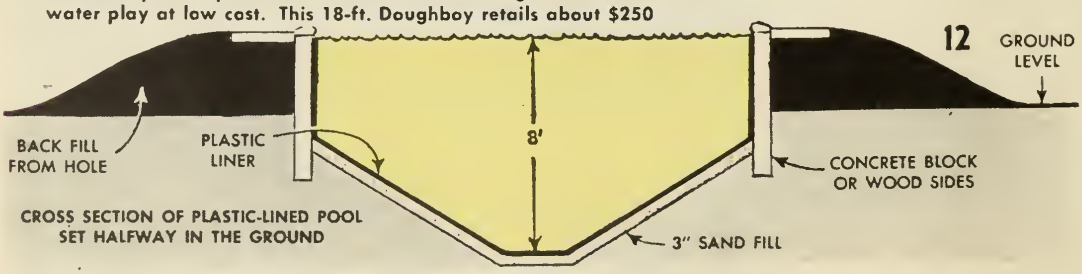
Portable plastic pools afford limited swimming but lots of water play at low cost. This 18-ft. Doughboy retails about $250

If your family is not particularly interested in diving, a pool with 5½ to 6-ft. depth is fully ample for active swimming and for diving from the pool's edge. A contractor will build the shallower pool for $500 to $1000 less, depending on its size, and it is much easier to build yourself. The depth also makes a considerable difference in the heating the water will receive from the sun. In many fairly cool regions, the shallow pool will be warm with no heating unit at all.

However, for adults and even small children, a shallow end with less than 3-ft. depth usually is unsatisfactory for swimming and play. For young toddlers, rather than reduce the shallow end to a 2-ft. depth or less, give them a separate plastic wading pool, or plan to keep the water in your pool a foot below normal level for awhile, or build an oversize playpen with a raised plywood floor to sink in the shallow end until the children learn to swim. The sides of a pool should be vertical for about 30 in. down to allow active swimming close to the edges.

Most pools today are built of Gunited concrete. A builder's tab for a large fully-equipped 20 x 40-ft. Gunited pool placed in your yard will likely be over $5000, over $3500 for a 16 x 34-ft. pool. A Gunited pool has the advantage of being available in any shape desired and very easy to clean. Applied under pressure, the Gunited concrete is stronger than poured concrete, usually needs to be only 4 in. thick, and as its sides are curved there are no weak corners to give cracks. The Gunited concrete is reinforced with steel as shown in Fig. 7.

An equally strong pool can be built of poured, reinforced concrete, practically the same as building a basement. However, the squared corners at the bottom of a poured pool are somewhat difficult to clean, add nothing to swimming



CROSS SECTION OF PLASTIC-LINED POOL SET HALFWAY IN THE GROUND

and give more water to treat and heat. In areas close to the manufacturer, precast concrete pools give another practical method. The precast walls are joined to a poured concrete bottom, giving a good solid pool.

Some companies and many self-builders have eliminated the wood forms of poured concrete pools by "dry-packing," Fig. 8, using a fairly stiff concrete mix which is shoveled and packed in place by hand, almost like plaster. Such a pool shell can be rounded the same as a Gunited pool; has more strength that way. The shell needs to be extra thick because the dry-packed concrete has low density and strength. Most Gunited, poured and dry-packed pools are finished off with a white calcareous-base plaster coat (contains marble dust instead of sand) which gives a lifetime finish to a pool kept clean and filled year-round. Applying this special finish is tricky and requires an experienced pool plasterer. Ordinary plasters containing lime will disintegrate under water and should never be used.

Concrete-block construction has been used satisfactorily for pools. At a glance, the construction seems easier to do yourself than poured or dry-pack concrete but it actually is more difficult because the blocks must be very carefully laid and reinforced to prevent cracks. Concrete blocks give a weaker pool shell than concrete and should not be used on filled ground or elsewhere where subject to any disturbance. For the same reason, most block pools are finished with a heavy vinyl liner rather than a plaster finish. The cost, contracted, of a fully-equipped pool is about 10 to 15 percent less than for a gunited pool.

A vinyl-lined pool with a sand bottom and shallow sides reinforced with poured concrete, concrete block or wood gives you a "real" pool at the lowest cost. One builder of custom-made Gunited pools has do-it-yourself vinyl-lined kits available. A kit for a 20 x 40 ft. pool costs $1320; $870 for a 16 x 32 ft. pool, and $700 for a 12 x 27 ft. pool. The kit includes a double-thickness vinyl liner made to size, a complete sand or diatomaceous-earth filter, the pump required, and all pipe and fittings needed. You supply the hole and lay the plumbing and liner. Such heavy vinyl linings have a life expectancy of at least 10 years and can be replaced. While the lining can be pierced by a sharp object, to patch any but a small break does require emptying the pool. Fig. 12 shows a half-sunk construction that is easiest for a vinyl-lined pool. You place the retaining walls only about halfway down in the ground and use the excavated earth as a fill to secure the sides.

The larger portable "splashing" pools of about 3-ft. depth allow some swimming, and are available today at a cost as low as $200 to $300 complete. They are simple to erect, are filled and emptied with a hose and can be stored away in winter. Some more permanent types are sunk halfway into the ground, like a plastic-lined pool. Similar pools have been built by simply digging a rounded hole and lining it with heavy asphalted roofing paper. As on a roof, the laps of the paper are sealed with asphalt and all is finished with a roofing paint, preferably one with an aluminum base. Such a sunken pool will hold water and is very inexpensive if you build it yourself. However, it is easily damaged and the most difficult of all to keep clean.

Your swiming pool can operate either as a fill-and-draw or recirculating type. A fill-and-draw pool works like a bathtub. It is filled with water and then drained, scrubbed and refilled whenever necessary. Because algae can form in as little as three days time in summer, this refilling and cleaning can be quite a chore, requires a large source of water and usually is practical only in rural areas where water is cheap and can be used afterwards for irrigation. Some owners chlorinate their fill-and-draw pools and thus the water will stay clear for weeks, but getting rid of the chlorinated water is a problem in most yards because it kills vegetation. Running a small stream of fresh water continually through the pool seldom is successful because it usually is not enough to keep the pool clear, gives a cold pool and does not allow any chlorination. Some good fill-and-draw pools along seacoasts use salt water pumped from the ocean. For such, a good idea is to expose the piping and paint it black so the sun will warm the water before it enters the pool.

Almost all permanent pools built today are recirculating and the larger portable plastic pools, which are fill-and-draw, usually are made recirculating sooner or later by adding a portable pump and filter unit. In any recirculating pool, the water is pumped through a filter system and then a heater, if included, and back into the pool. Surprising to many people is that the same water is used for years—a closed circuit—adding only the little lost to evaporation and backwashing of the filter, and that amount will never show on your water bill. After filtering, the water is much clearer than when it comes from city mains. Its purity is easily maintained and the filtered pool does a good part of its cleaning automatically.

Fig. 6 shows a completely equipped recirculating pool using a sand-and-gravel filter. The pump draws half its water from the lowest point in the pool, half from the surface skimmer. Thus it constantly

"drains" sediment from the bottom and skims leaves and pollen from the surface. Leaves are caught by the skimmer, smaller particles by the pump strainer and dissolved dirt, etc., by the filter. The water then passes through the heater, if included, and back to the pool through one or more openings, preferably at the shallow end so that the flow will sweep most of the bottom.

Note the number of valves. They let the system do several things. As shown in Fig. 6, the system is operating normally. To power a pool vacuum cleaner, you simply close skimmer valve No. 1 and bottom drain No. 2, then open valve No. 3 in the vacuum-cleaner line. The opening for the latter is located below the water line so air cannot enter. There are four valves for the filter. To backwash and clean the filter, you close valves No. 5 and 6 which are normally open, and open valves No. 4 and 7 which are normally closed. The pump then forces water in at the bottom and flushes the collected debris out the top of the filter and on to waste in a dry well or sewer line. If your pool gathers a large amount of dirt from a storm, you can bypass the filter and vacuum the dirt directly to waste by opening valves 4 and 5 and closing valves 6 and 7. Some new filters have a single four-way valve which accomplishes the same as the four valves shown.

The latest versions of diatomaceous-earth skim-filters are as efficient as the sand-and-gravel type and of special interest to anyone building his own pool, because they include built-in skimmers and eliminate much of the plumbing ordinarily required. These compact filters are installed directly alongside the pool shell as is a separate skimmer. Some include the back-flushing and vacuum-cleaner features of a sand-and-gravel filter and require for maintenance only a handful of diatomaceous earth added each week. Some others use replaceable filter cartridges. This type of filter, or the separate skimmer of a sand-and-gravel filter, should be located on the side or corner of the pool where the prevailing wind most often deposits floating debris.

The left-hand detail in Fig. 6 shows the action of a modern skimmer. It is a large plastic tube with a ring-shaped float in the top so the tube will just barely float and will be sucked down about ½ in. below the water level whenever the filter pump is operating. Thus, water is drawn off the surface only, along with any floating material, regardless of daily changes in the pool level. The skimmer moves up and down inside a perforated metal basket, which catches the leaves, etc. The 1-in. pipe with rubber flap valve is included to prevent the pump from drawing air if the water level should fall below the skimmer's inlet and to let it draw a full flow if the skimmer basket is clogged with leaves.

In the past, a pool heater was considered a definite luxury but today three out of four permanent pools have heaters. One will raise the water's temperature to well over 80 deg., and, more important, will do so in early spring and late fall. In most climates a heater doubles the months you will use your pool. A modern pool heater is not cheap, costs from $400 to $600, depending on your pool's size, and from $10 to $25 for fuel each month of full operation. House water heaters cannot be used because they will not heat water constantly passing through. The flow of the filter pump needs to pass fairly slow through most pool heaters. Therefore, a bypass line with a valve usually is included there, Fig. 1, so you can adjust the amount of the flow through the heater.

Patching a Leaky Swimming Pool

It is unnecessary to drain a concrete swimming pool or other concrete tank to make repairs. Just mix the necessary cement for the job and, when ready to apply it, mix a trowel or two of the cement with about one third that amount of quick-setting plaster of paris. Press this into the hole under the water to stop the leak immediately, and then proceed with regular cement to complete the job.

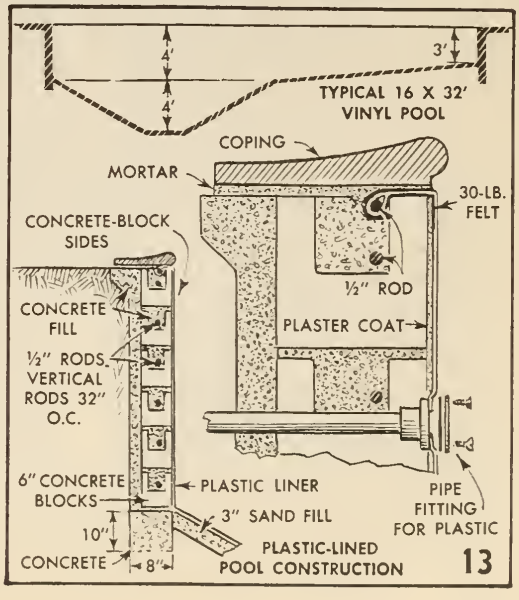
Holes in Plastic Pool Sealed With Bandage

Small punctures in a plastic beach ball or wading pool can be repaired by using a patch cut from a plastic adhesive bandage. Larger holes or tears can be similarly repaired but generally require an additional patch applied to the inner surface to provide extra strength. — Samuel B. Rentsch, Jr., Glastonbury, Conn.

GET IN THE SWIM

BY BUILDING YOUR OWN POOL

IF YOU ARE planning to build your own concrete pool, you will need to obtain a good set of plans locally. You need on-the-spot plans because each concrete pool is different, depending on its size, shape, the soil supporting it, the temperature extremes of the area and whether it is to be Gunited, poured or dry-packed. Today there are two good sources of concrete-pool plans. Many large cities now have engineering firms which specialize in designing home pools. They furnish the plans many pool builders use. One of these firms will inexpensively check your site and plan the pool you desire for it, including complete plumbing blueprints and also for the steel reinforcing of the shell. Or you can arrange with a pool-equipment dealer to buy all the necessary equipment from him. You have to buy it somewhere and in return most dealers today will similarly go over the site

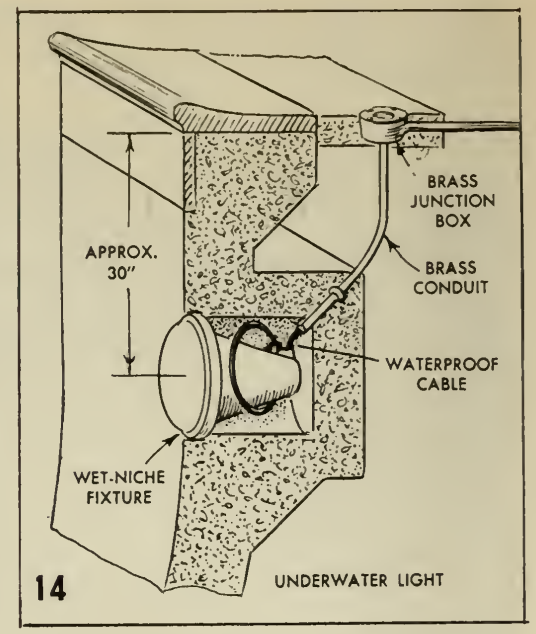


and furnish plans for your particular pool.

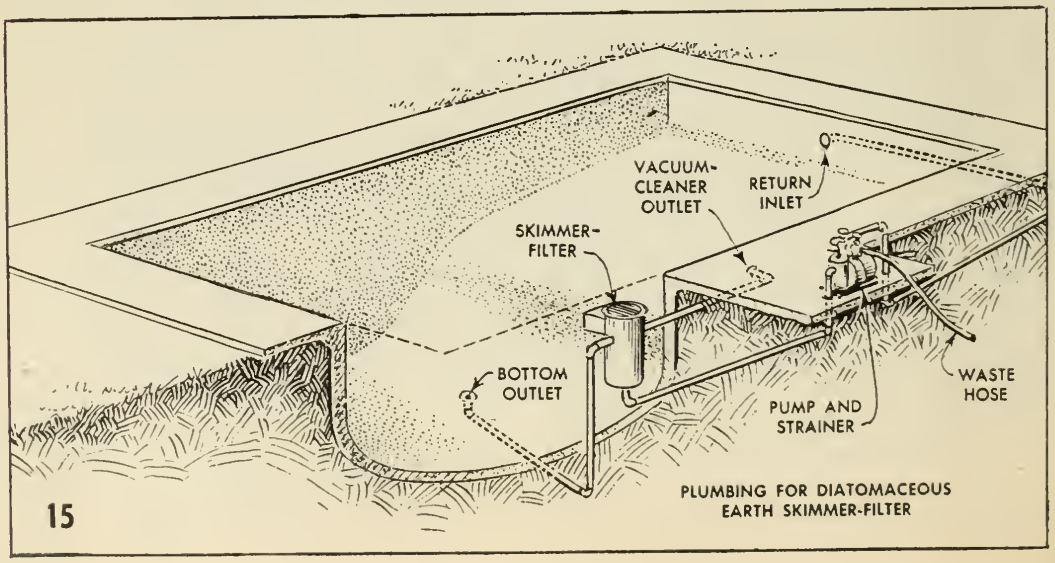
Glass fiber and metal pools come with complete installation plans, as do the plastic-liner pool kits. Because they are quite flexible, the inexpensive plastic-lined pools with sand bottoms can be built by the same plans in warm and cold climates and in different soils. Concrete blocks are as practical as poured concrete when laid and reinforced as shown in Fig. 13. The block sides should be given a thin waterproof plaster coat to assure a smooth surface for the plastic lining. A plastic-lined pool shaped approximately as shown in Fig. 13 will give better swimming and diving features than one with a flat bottom. The detail also shows a good way to anchor the lining at the top of the pool. A ½-in. reinforcing rod is slipped inside the cuff of the plastic lining (or is rolled up in it, if no cuff) and then is embedded in the mortar joint under the coping. A strip of building felt will protect the plastic at this point from any sharp edges of the masonry. The mortar joint can be broken easily with a chisel and the coping removed if the lining should need replacing.

Digging the hole for the pool by hand is plain hard work and no saving today when a tractor-loader or small backhoe will dig it so quickly and inexpensively. About 24 man-hours with a flat shovel and a mattock is usually needed to smooth and finish the hole. Plan to dig the hole and lay the concrete or other shell in as short a time as possible, to eliminate the one big hazard of pool construction — a cave-in of the raw earth sides from a sudden rain.

With good plans, you can lay the plumbing and the reinforcing steel for a Gunited pool yourself without complications. Then the crew brings in its Gunite equipment and sprays the shell, usually in one day, at an average cost of about $700.



For a dry-pack concrete pool, be certain to use the extra thickness and the amount of reinforcing wire recommended by your plans. The sides are packed first, packing the stiff mix in a spiralling manner around the pool so that no great amount of fresh mix needs to be supported in any one place. Some of the mix will probably sag down but can be worked back up the sides with a trowel or spread on the bottom. At the top, the sides are completed by packing the mix behind leveled boards. The bottom is poured last. The secret of a good dry-pack job is to have several persons on hand to shovel, pack and smooth the pour.



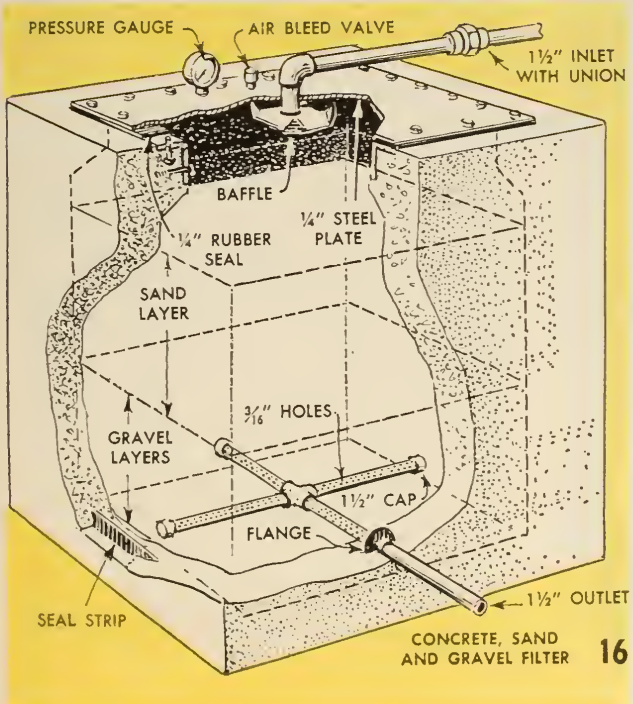
Once the excavation has been made work can move rapidly through several stages to the finishing touches. Note coping form

If you plan to have an underwater light in your pool, a small niche to fit the light you obtain needs to be formed in the pool wall when the shell is built. Fig. 14 shows a typical installation. The waterproof light fixture usually is placed in the deep end directly under the diving board. It can be either 300 or 500 watts, is grounded and is surrounded by water for cooling. A length of waterproof cable looped inside the niche allows the fixture to be removed and lifted above water for replacing the bulb.

Usually, the finish coat of white calcareous-base plaster is laid on a concrete pool five to seven days after the shell is built. If the shell is rough, a thick coat of waterproof grout (sand and cement, plus anti-hydril or tricisal) is plastered on first. If an expert is not available to apply the calcareous-base plaster it is probably best to apply a smooth coat of the waterproof grout and finish the pool with vinyl or chlorinated-rubber swimming-pool paint.

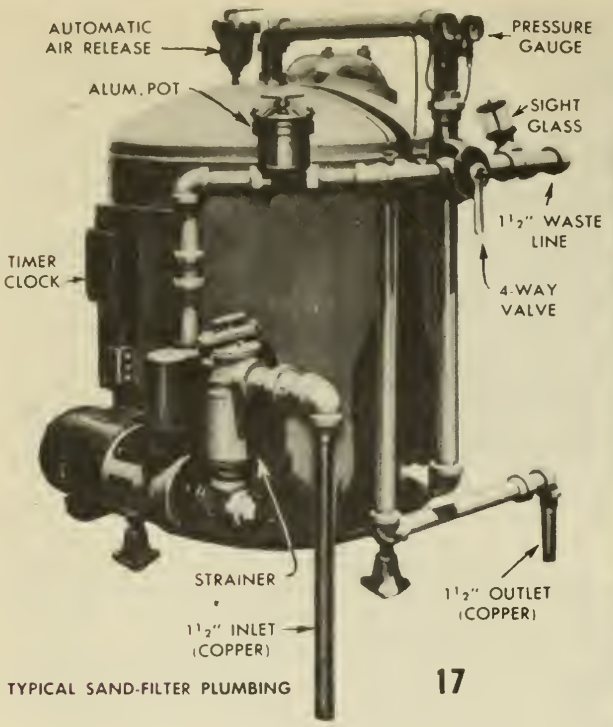
The water line of one or two rows of ceramic tile is cemented in place before the finish plaster is laid. Tile of light-blue color is the most popular, giving a blue reflection to the water, but warm colors, such as peach, orange, or maroon, are also good as their contrast intensifies the blue of the water. Because filtered water is a brilliant turquoise blue when it has a white background, the plaster or other finish of a pool shell is best a bright white. A blue shell gives a dark pool.

Most pools today are trimmed along their top edges with precast coping blocks, which are available from any pool dealer. They are slipproof and their bullnosed shape gives a good handhold and drainage away from the pool. Cut-flagstone and brick also give attractive pool copings, but their rough surfaces are not too practical for children. Scum gutters along the water line are obsolete today. A small skimmer does a much better job of removing floating material, and gutters are difficult to build and to keep clean. A deck or paved walkway 3-ft. wide around the pool is desirable, and it should slope away from the pool at a slant of 1 in. in 4 ft. for drainage. Grass up to the coping means clippings continually tracked into the pool and the splashings of chlorinated water will brown nearby grass. Most decks are of poured concrete, the surface being finished slightly rough so it will not be slippery. Flagstone, brick and wood blocks also are good.



Even if you do not plan at present to have a filter system or heater, it is advisable to stub in their piping when the pool shell is built. Copper pipe is best; galvanized pipe deteriorates in chlorinated water. Follow the pipe sizes specified in your plans, usually 1½ to 2-in. diameter, and if in doubt, use a larger size. Especially for a sand filter, use the recommended pipe, pump and strainer to have a strong backwash flow which is needed to clean the filter properly.

Fig. 15 shows the simple plumbing required for a diatomaceous earth skimmer-filter. The pump and its strainer usually are placed



TYPICAL SAND-FILTER PLUMBING

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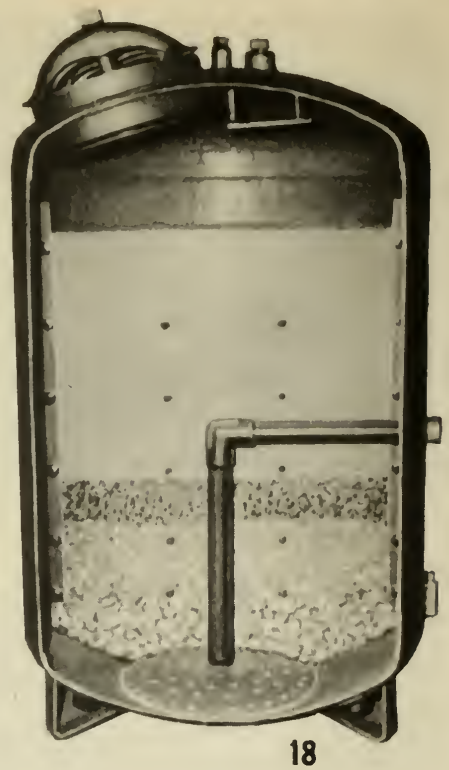

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Filter and water-heating equipment generally can be installed in a cabana or other structure near pool. Fig. 17 shows the complete filtering unit with all fittings while Fig. 18 is a cutaway view of the sand filter showing how washed gravel in three gradations, is placed in the container and covered with sand

Diatomaceous earth skimmer-filter with cloth filter removed from drum, or container. Unit requires comparatively little water for back-washing filter periodically

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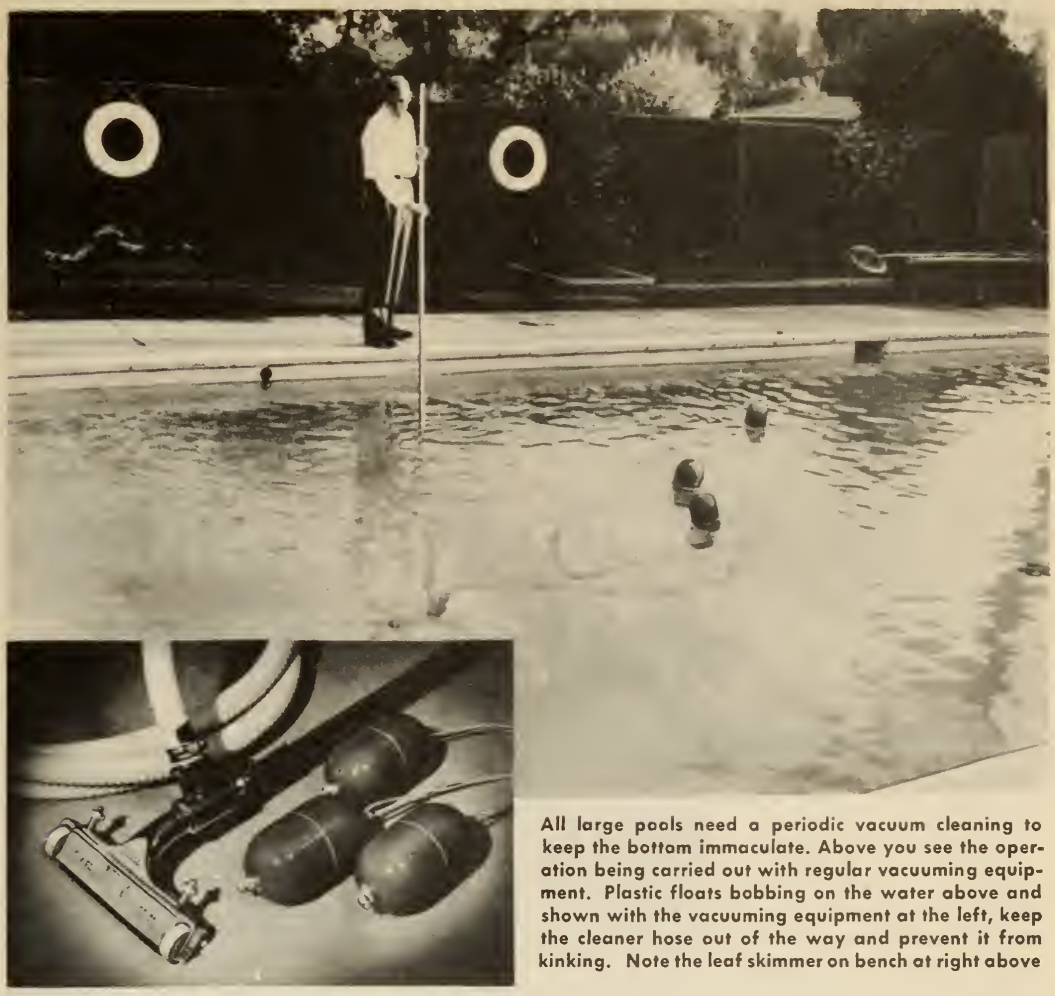
above ground near the pool and can be enclosed inside a small wooden bench. Backwashing this type of filter requires very little water and so the line to waste usually is just a plastic hose that is unrolled to drain the water somewhere into the ground.

You can build your own sand filter if you wish of concrete as shown in Fig. 16, or you can similarly adapt a heavy-metal tank by fashioning a removable lid on it of at least 10-in. diameter. For the average pool, the filter should have a 3-ft. inside diameter and 4½-ft. depth. Cast the bottom of a concrete filter first, including a 2-in. strip of galvanized flashing around the edges as shown, to give an extra seal for the joint with the sides. Forms should be arranged to pour all four sides at once, with the outlet piping and top angle iron in place. Let the caps of the perforated pipes extend slightly into the concrete walls to keep the pipes from moving. Use one of the waterproofing additives in the concrete.

Where the outlet pipe extends through the concrete, a pipe flange or similar fitting is slipped over the pipe and welded in place to give a water seal. The inlet pipe is welded to the lid and has a union for removal in case the sand should ever need relaying. A simple baffle to spread the inlet flow is made by bending the corners of an 8-in. square of heavy plate and welding the corners to the lid as shown. A water pressure gauge is attached to the lid or



All large pools need a periodic vacuum cleaning to keep the bottom immaculate. Above you see the operation being carried out with regular vacuuming equipment. Plastic floats bobbing on the water above and shown with the vacuuming equipment at the left, keep the cleaner hose out of the way and prevent it from kinking. Note the leaf skimmer on bench at right above

inlet pipe to tell when the filter needs backwashing, and usually a second gauge is attached to the outlet pipe. The water pressure in a filter is not high, usually about 10 lbs., but the concrete should be reinforced with wire and the steel lid needs a thick rubber gasket and to be secured with ⅜-in. bolts every 4 in.

The completed filter is filled 39 in. deep with level layers of sand and gravel. Fill the bottom 8 in. deep with 1 to 1½-in. crushed gravel. Over that lay 3 in. of ½ to ¾-in. gravel, then 3 in. of ¼ to ½-in. gravel followed by 3 in. of ⅛ to ¼-in. gravel. The final layer is 22 in. of No. 16 filter sand. This is a coarse, heavy sand available from pool dealers.

A cabana or dressing room for the pool is an extra you can add later or do without if there is a bathroom available nearby in the house. The cabana can be of almost any design. Basic requirements are privacy, drainage, a place to sit down, a place for towels and a good-sized storage place for the face masks, fins, floating toys, etc., that gather around a pool. The filter and heater equipment usually go in a "boiler room" in the cabana or in a small shed near the pool. In warm regions, cabanas are often built without roofs and the filter system is often left out in the open.

If you live near a small stream, the water supply problem usually is simple. Just install an intake box below normal stream level to house a submersible pump. Locate the pool so that its water level when full is well within the lift capacity of the pump. Fig. 21 suggests a method of installation, using natural stone laid in mortar for the pool sides and a layer of selected flat stones overlaid with concrete for the bottom.

Maintenance

Throughout the swimming season the maintenance of the average pool is about the same as that for the average lawn—totaling approximately two hour's time for cleaning, plus a few minutes each evening for treating the water and emptying the skimmer. A poorly-planned pool can more than double the maintenance time.

The weekly cleaning is a matter of wip-

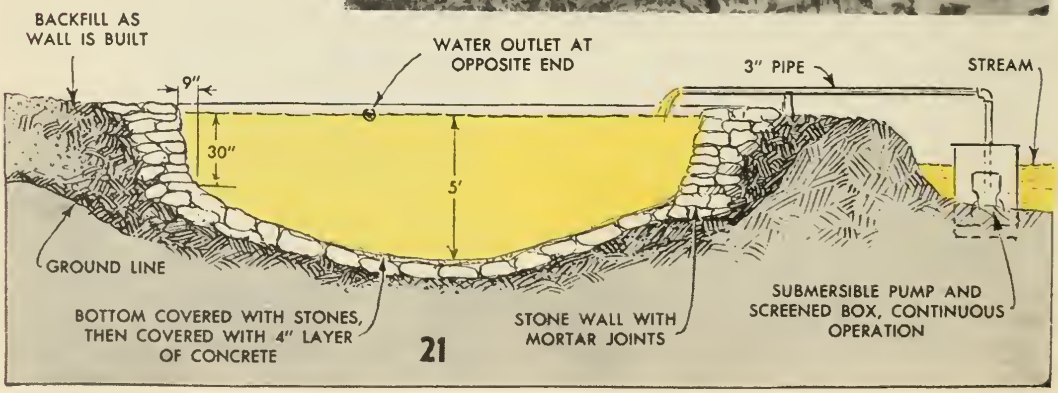
ing any "bathtub ring" from the water-line tile, scooping out any floating leaves the skimmer may have missed with a leaf skimmer (a long pole with a small flat net at the end), brushing down the pool sides with a brush on another long pole, and then vacuuming the pool bottom. The bottom of a small or seldom-littered pool often can be cleaned by just using the pool brush to sweep any sediment down to the bottom outlet where the filter pump will draw it away, but most pools will require a vacuum cleaner to keep the bottom immaculate. There are two types of cleaners. The standard heavy-duty version is simply a 1½-in. flexible hose with a vacuum-type nozzle that is plugged into the vacuum cleaner line of the filter system. The other is independent of the filter, operates by venturi effect from the water pressure supplied by a garden hose and has its own bag to collect the debris. It is handy for small pools.

The skimmer at the edge of the pool usually needs emptying every other day, or oftener if it gathers a clogging amount of floating material. The strainer at the pump needs emptying much less often. The pump is operated a sufficient number of hours each day to keep the water clear—the average being about twelve hours but varying with size of your filter and pool and with the season of the year. A timer clock usually is installed to turn the pump on and off automatically each day. If anything, it is best to over-filter your pool because the electricity used by the pump is insignificant and a clean pool requires less chemical treatment.

Most filters have two pressure gauges, one giving the water pressure at the top inlet, the other the pressure at the bottom outlet. As the filter loads up with dirt, the pressure differential will increase. When the top gauge reads 5 to 7 lbs. higher than the lower gauge, the filter should be backwashed by reversing its flow as described on page 1796. Accumulated dirt is flushed away and the thick sand layer of the filter is lifted and scoured clean by the water flow. The piping to the sewer or dry well usually has a sight glass. You stop backwashing as soon as the water in the glass is clear.

After every backwashing, a small amount of alum is fed into the top of the filter via an alum pot on the inlet line or by dropping it into the pump strainer. In the

This rustic pool in its woodland setting is the nearest thing to the old swimmin' hole. It's completely informal in plan and design and of course it's a natural for a wooded yard. If there's a small stream nearby the water-supply problem can be solved by installing a submersible pump



slightly alkaline water of a pool, the alum coagulates into a soft floating mass on top of the filter bed. This soft floc, not the sand, catches the finer particles in the water and the used floc is flushed out with the backwash. One to three lbs. of alum per 10 sq. ft. of filter bed is ample; more should not be used.

Most diatomaceous earth filters are cleaned similarly. First, the built-in skimmer is emptied and then the water flow is reversed by a valve or other arrangement to backwash sediment and soiled diatomaceous earth to the waste line. When the water being flushed through the filter is clear, it is turned back to normal flow and a handful of diatomaceous earth is dropped into the top of the filter. The earth immediately recoats the cloth elements of the filter and it is back in operation. These filters have no pressure gauges to tell when to backwash. Smaller in capacity, they should be backwashed weekly or more often if experience dictates.

You become quite an amateur chemist when you own a pool. Besides treating the filter, the major item is proper chlorination of the water. Chlorinating does two important jobs—purifies the water and stops the growth of algae. Algae are microscopic one-celled plants which are everywhere in the air and in all water, even that drawn from deep wells. They multiply rapidly in the combination of sunlight and warm water and so are especially a factor with swimming pools. Most algae are green in color and can turn the water of an untreated pool a muddy green in three warm days. Some will turn the water brown and some stubborn black algae collect and multiply on a pool's sides and bottom. Other treatments—ultraviolet lights, ozone, silver ion and bromine—have been used with some success but chlorination has continually proved the simplest and best treatment for a residential pool.

You can chlorinate two ways, with calcium hypochlorite or liquid sodium hypochlorite. Calcium hypochlorite is a powdered chemical commonly available and it can be thrown directly into the pool but is better dissolved with water in a gallon jug and poured around the sides so the calcium solids will settle in the jug instead of on the bottom of the pool. Liquid sodium hypochlorite is simply poured out of its jug into the pool. Household bleaches, such as Chlorox and Purex, are sodium hypochlorite solutions and can be used in the pool but a mix of three times stronger chlorine content obtained from pool dealers usually is less expensive. Inexpensive feeders are available today which will feed either of the above liquid mixes into the filter piping automatically. A third method of chlorinating, feeding chlorine gas from pressure cylinders into the filter lines, gives the cheapest chlorination of all but is usually practical only for large public pools. The equipment required is quite expensive and the poisonous gas requires constant attention.

Pool experts advise your maintaining a free chlorine residual of 0.2 to 0.5 parts per million parts of water during the swimming season. This may sound complicated but is easy to obtain by following the daily dosage recommended by the supplier of the chlorine you are using and then checking yourself with an inexpensive pool testing kit. You add a few drops of its ortho-tolidine solution to a test tube of water dipped from the pool (within two hours after chlorinating) and compare its color with the sample tube provided. More chlorine is needed if the color is paler than that of the sample, less if more yellow. Actually, few home pools are kept precisely at the above chlorine residual, especially 24 hours a day. The chlorine dissolved in the pool is a gas that sunlight burns away rapidly. Therefore, a small amount of chlorine is usually added each day, in the late afternoon or evening, to bring the water back to or near the recommended residual. The chlorine will stay in the water throughout the night. During the heat of the following day, especially if the pool is heavily used, the chlorine dissipates to where a test may show none at all in the afternoon. That is of no consequence, because the water will be rechlorinated in the evening and bacteria and algae will not have time to grow.

Some algae do became immune to the usual chlorination in time and therefore it is advisable to give your pool a "shock treatment" about every three weeks during the swimming season with a triple dose of chlorination to kill any stubborn algae in the water. The extra chlorine will dissipate in a few hours of sunlight and on a dull day within about 24 hours. The daily chlorination is the one treatment of significant cost. For a 16 x 34-ft. pool, the chlorinating averages about $10 each summer month.

Most pool test kits also contain a PH test for the water's alkalinity-acid balance. Occasionally and after any special treatment, you should dip the other test tube into the pool, add a few drops as specified by the kit of its phenol-red solution and compare with the PH color sample provided. It is important that your pool water register slightly alkaline. If acid or highly alkaline, it may turn cloudy in the pool (resemble household ammonia). If the least acid, it will in time attack the plaster finish of a concrete pool, also the metal of the filter and plumbing and it will dissipate chlorine very rapidly. If too alkaline, the

effectiveness of the chlorine in the water is greatly reduced. Most water has the correct balance, is slightly alkaline by nature and if off either way can easily be corrected. An acid condition is corrected by broadcasting a small amount of inexpensive soda ash in the water, about one lb. for each 5000 gallons. Repeat the dosage at two-hour intervals, if needed, to bring the water to proper PH balance. For high alkalinity, sodium bisulphite in the same dosages or equivalent amounts of muriatic acid is used. These amounts of chemicals are so minor the pool can be used for swimming immediately after treatment.

Occasionally, the fresh water used to fill a pool contains a high amount of iron, manganese or other metallic salt. Suspect this condition if your house sinks show a yellow or reddish-brown stain beneath their faucets. The water may be perfectly clear when drawn, but exposure to sunlight and chlorine can precipitate the metal to continually cloud the pool and deposit a yellow or reddish rust on the bottom. Also, a few hard waters will deposit a scale, usually calcium carbonate, on pool sides and bottom. The scale stains plastered pools and can give a surface as rough as coarse sandpaper. Either of these conditions can be remedied by refilling the pool with more suitable water, by treating it with chemicals or by using a water softener. Often a portable water softener can be rented from a pool dealer for a one-shot treatment to clear the pool. Carefully follow the advice of your local pool dealer when softening water with either chemicals or a water softener, because the treatment varies considerably with different waters. Test the water immediately after treatment for proper PH balance and correct if off.

Winter Care

As with a lawn, a pool's maintenance is much less in winter. The growth of algae and bacteria is greatly reduced in cold or cloudy weather and the pool is seldom used. Some owners in cold regions practically ignore their pools throughout the winter, just drain and scrub them thoroughly in the spring. Most owners give the pool a partial winter maintenance, clean out collections of leaves and give the water a triple dose of chlorine during stretches of warm weather or any time the water turns green. In warm climates full filtration and chlorination is often continued (with considerable less chlorine treatment) for an occasional dip on sunny days or just to keep the pool attractive.

Almost all experts today recommend leaving your pool filled throughout the winter. A frozen-over pool will equalize the frost pressure of the surrounding ground, is much less likely to move or crack. In very cold areas, softwood logs of 10-in. diameter or more are often secured in the water around the perimeter of the pool by short ropes attached to stakes in the ground beyond. The logs weaken the pressure and break the expanding force of any heavy surface ice. Wherever freezing temperatures are expected, the level of the pool should be lowered in the fall to drain all inlet, outlet and vacuum lines above frost level and those are plugged to stay empty when the pool is refilled. Often, the pump and its motor are disconnected and stored elsewhere. The filter and heater and their piping also are drained.

A filled pool throughout wintertime eliminates the hazard of someone falling into an empty pool. Occasionally, an empty glass-fiber, metal or plastic-lined pool, sometimes even a concrete pool, will float up out of its bed from the pressure of ground water. If filled, it will not. Plastic covers are available today for pools which are simply spread over the surface, floating on top of the water. They will support a child should he fall in, will keep leaves and dust from entering and further reduce algae growth. The diving board, pool ladder and such are usually removed and stored elsewhere in winter.

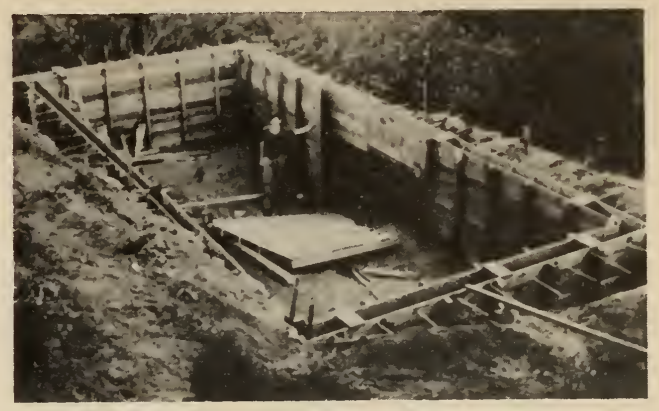
Pool maintenance, especially the summer chemical treatment, does sound complicated to the newcomer but it is quite simple once you become familiar with the routine. In some localities pool companies offer to take complete care of the pool—weekly cleaning, chemical treatment, backwashing, etc. — for about $35 a month. Doing it yourself requires about the same time but much less effort than maintaining a lawn. ★ ★ ★

SWIMMING POOLS

WHETHER it's large and elaborate or small and unpretentious, there's nothing like the privacy and convenience of a swimming pool right in your own back yard. And when you can do most of the work yourself or with the help of friends and neighbors, the cost can be kept well within the limitations of the average pocketbook. The suggestions and pointers presented here cover construction ranging from simple wading pools to a large family-size swimming pool.

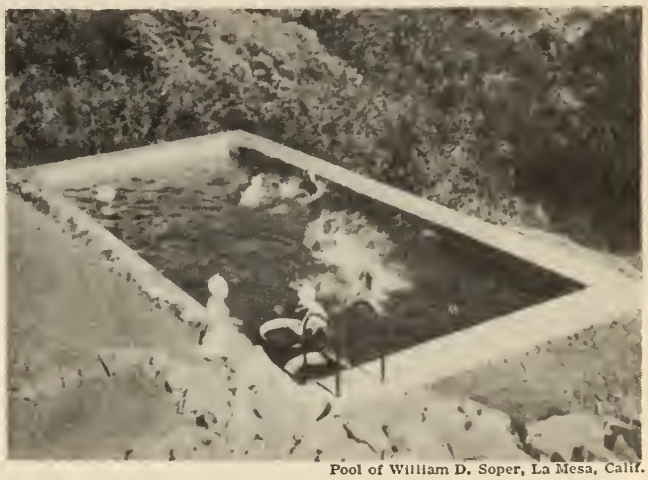
When building a wading pool for youngsters, locate it on high ground if possible to simplify draining and also to save excavating, Fig. 1. A simple circular-shaped wading pool is shown in Fig. 2. A novel feature of this pool is a sprinkler head which is attached to a length of pipe and screwed into a coupling on the drainpipe. The children will enjoy frolicking in the spray from the sprinkler while the pool is being filled. When the sprinkler head is not used, it is removed and the drain stopped with a pipe plug, Fig. 2. The sprinkler feature is practical only if the drainpipe outlet is easily accessible for attaching a hose. Galvanized sheet metal or heavy linoleum makes ideal forms for a circular pool. Fig. 7 shows how stakes and cross braces are used to support metal forms. As a safety precaution, do not make the depth of the pool at the center more than 12 in.

Fig. 6 details a pool of unusual construction which is suitable for youngsters learning to swim. However, it is not desirable in regions where winter temperatures drop below freezing as the 2-in. walls will not withstand movement of the ground due to frost. The excavation for this pool is furred with strips nailed to stakes driven into the earth walls. Then metal lath is stapled to the furring strips and poultry wire is used in the bottom for reinforcement. Walls are plastered with cement and the



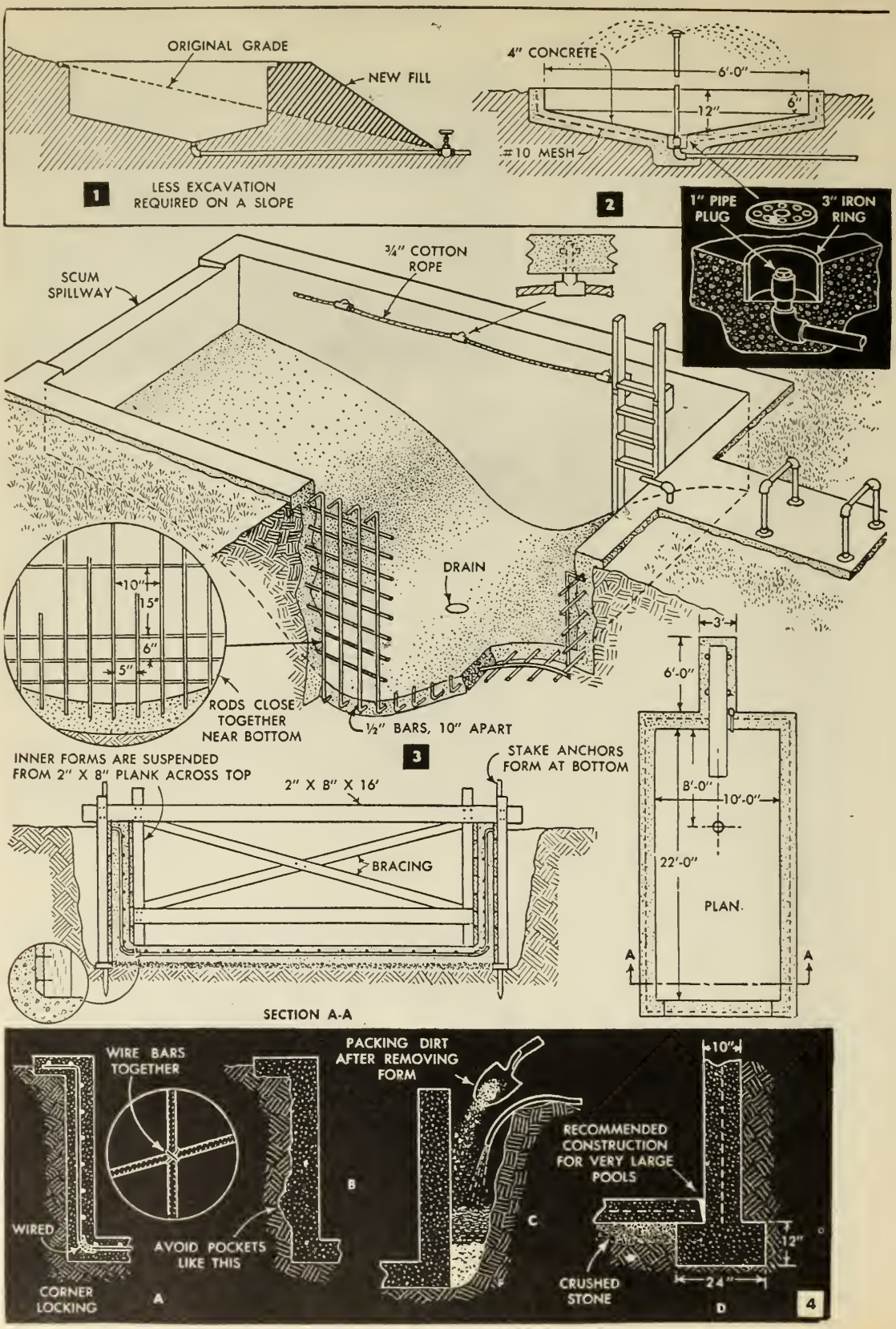
Here is an example of how a pool built on sloping ground reduces the job of excavating. Double-formed, pool is ready to be poured

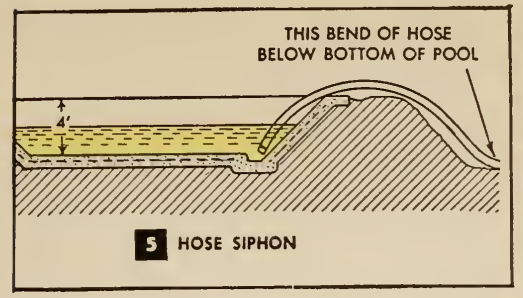
This view shows the pool poured, the forms removed and drain installed. Walls take less concrete when bottom of pool is sloped



Pool of William D. Soper, La Mesa, Calif.

Finished pool in use. Drainage is no problem of pool similarly situated. Here, drain in side carries water off for irrigation purposes. Note metal ladder which is embedded in concrete at time of pouring


ORIGINAL GRADE
NEW FILL
1 LESS EXCAVATION REQUIRED ON A SLOPE
4" CONCRETE
6'-0"
12"
6"
#10 MESH
2
1" PIPE PLUG
3" IRON RING
¾" COTTON ROPE
SCUM SPILLWAY
DRAIN
10"
15"
6"
5"
RODS CLOSE TOGETHER NEAR BOTTOM
½" BARS, 10" APART
3
3'
6'-0"
8'-0"
10'-0"
22'-0"
PLAN
A
A
INNER FORMS ARE SUSPENDED FROM 2" X 8" PLANK ACROSS TOP
2" X 8" X 16'
STAKE ANCHORS FORM AT BOTTOM
BRACING
SECTION A-A
WIRE BARS TOGETHER
WIRED
AVOID POCKETS LIKE THIS
CORNER LOCKING
A
PACKING DIRT AFTER REMOVING FORM
B
C
RECOMMENDED CONSTRUCTION FOR VERY LARGE POOLS
10"
12"
24"
CRUSHED STONE
D
4

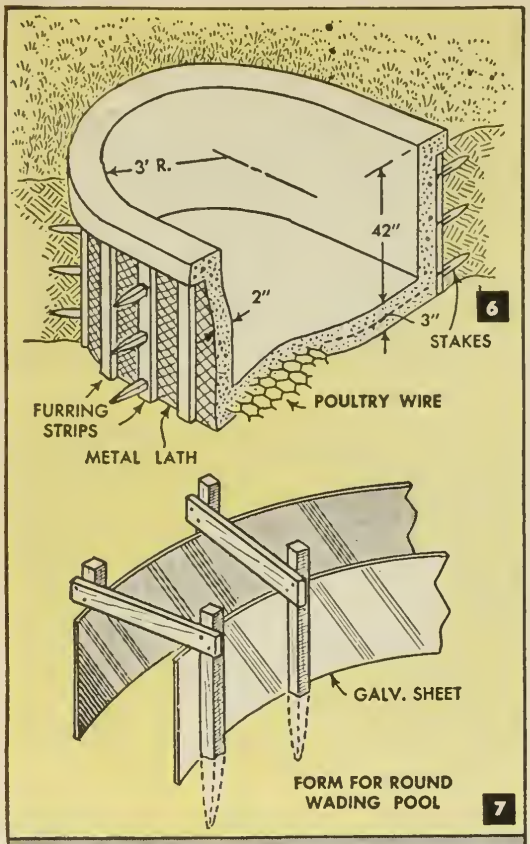


5 HOSE SIPHON

bottom is covered with a 3-in. layer of concrete poured over a 4-in. bed of gravel and strengthened with the wire. Finally, a reinforced curbing or parapet is laid around the edge.

An inexpensive pool without plumbing is shown in Fig. 5. Measuring 12 by 20 ft., it is designed for high ground to eliminate drainage piping and has sloping walls to do away with the need for forms. Bottom and sides of the excavation are tamped well and then 2 in. of concrete is poured over the bottom. This is reinforced with 6-in. spot-welded wire mesh, on top of which an additional 2-in. layer of concrete is poured. When the bottom is firm but still soft, the walls are plastered with cement to form an integral mass which is troweled into a parapet all around the top. The bottom is troweled to slope toward a sump from which the water is siphoned with a hose to drain the pool.

Figs. 3 and 11 detail an adult-size pool, 10 by 22 ft. Note that it is complete with water filter, centrifugal pump, suction-cleaning facilities, diving board and ladder. The deep portion just off the diving board slopes upward at each end to cut material cost. However, don't skimp on the wall thickness and the reinforcement. A minimum wall thickness of 6 in. is recommended for mild climates. Pools built in regions of severe cold should be 10 in. thick to avoid cracking. Section A-A of



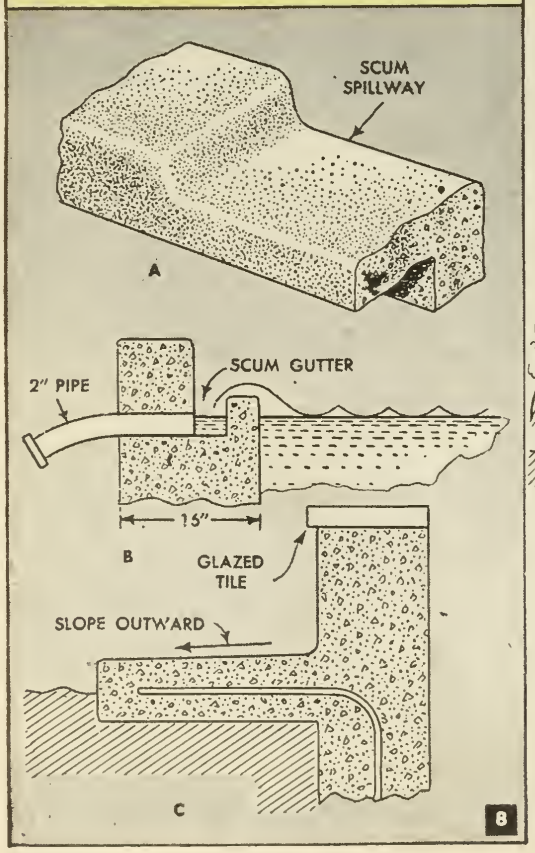
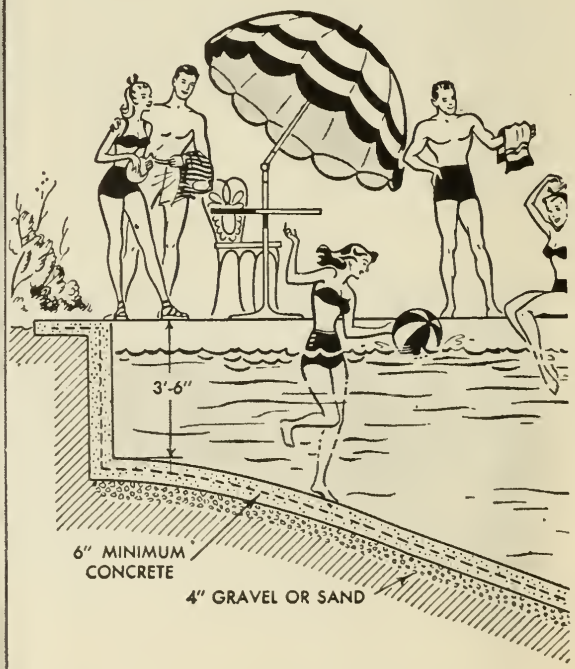


Fig. 3 shows how the pool is double-formed —with inside and outside forms, and how it is reinforced. Note that the inner forms are suspended from crossbeams and that stakes are used to prevent the outer forms from giving way at the bottom. Rods reinforcing the walls and bottom are wired together at the lower corner as shown in Fig. 4, detail A. The walls of large pools generally are poured on footings and a separate slab poured for the bottom, much like the foundation of a house. Then a mastic is run in the joint to make it watertight as shown in Fig. 4, detail D.

Figs. 9 and 10 give suggestions for making ladders of pipe or wood, and also plans for a springboard. The metal ladder should be of galvanized or stainless steel and embedded in the concrete at the time it is poured. Spruce is the best material for the springboard. Bevel the edges and cover the end with a nonslip padding of rope matting.

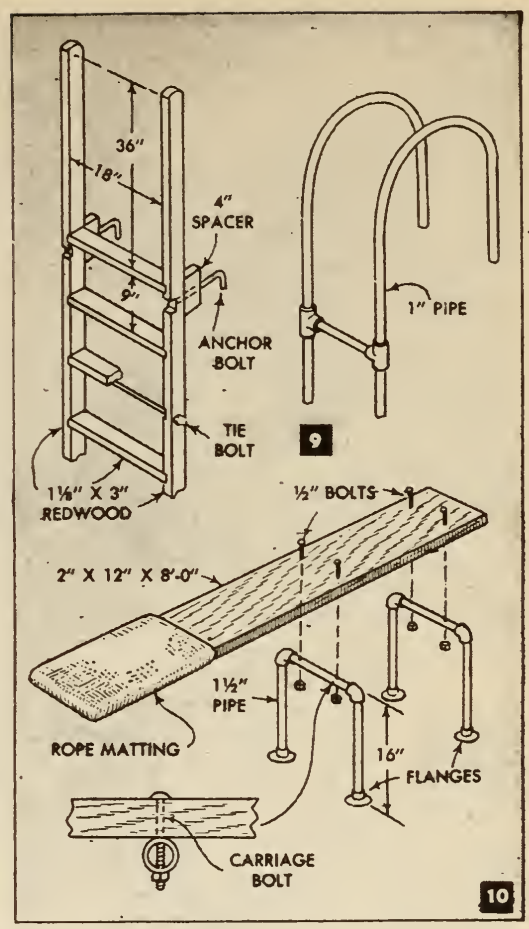
Three types of parapets are shown in Fig. 8. Parapets A and B incorporate a spillway in the top of the wall for floating off leaves and litter by raising the water level. In the case of B, drainpipes are spaced about 8 ft. apart all around the pool. Detail C shows construction of a parapet which extends above ground to provide a low seat around the pool and keeps debris from blowing into the water.

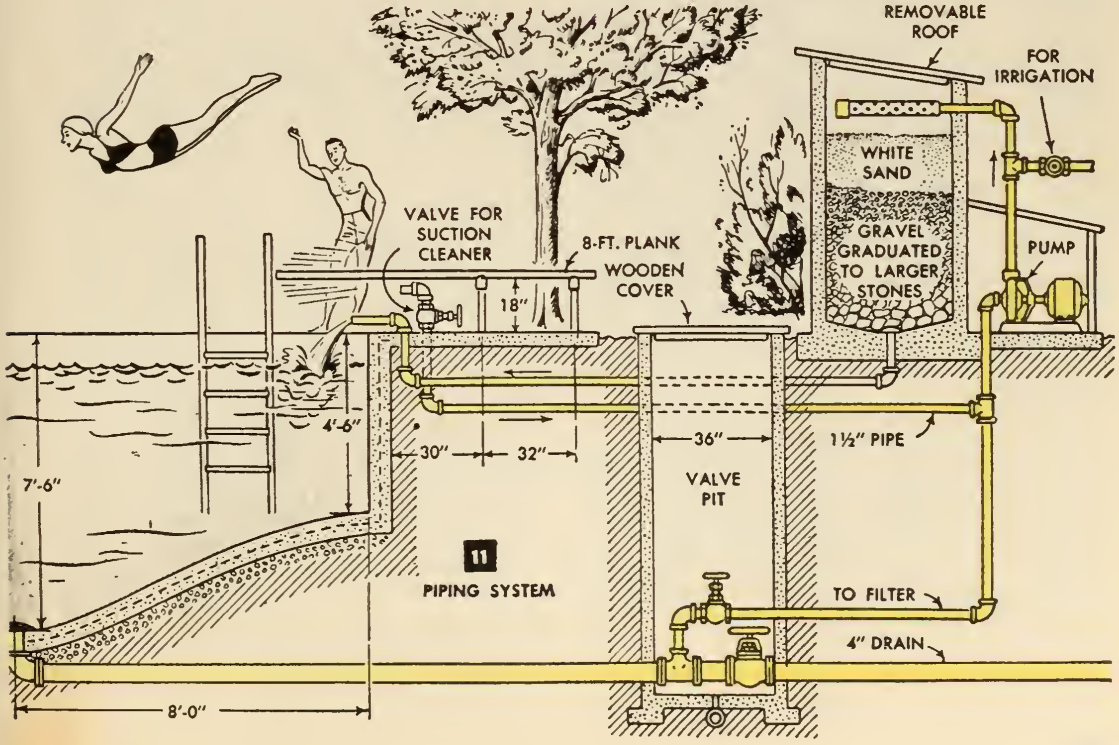
The concrete for small wading pools can be mixed in a wheelbarrow, but for large pools it is best to rent a small power mixer.

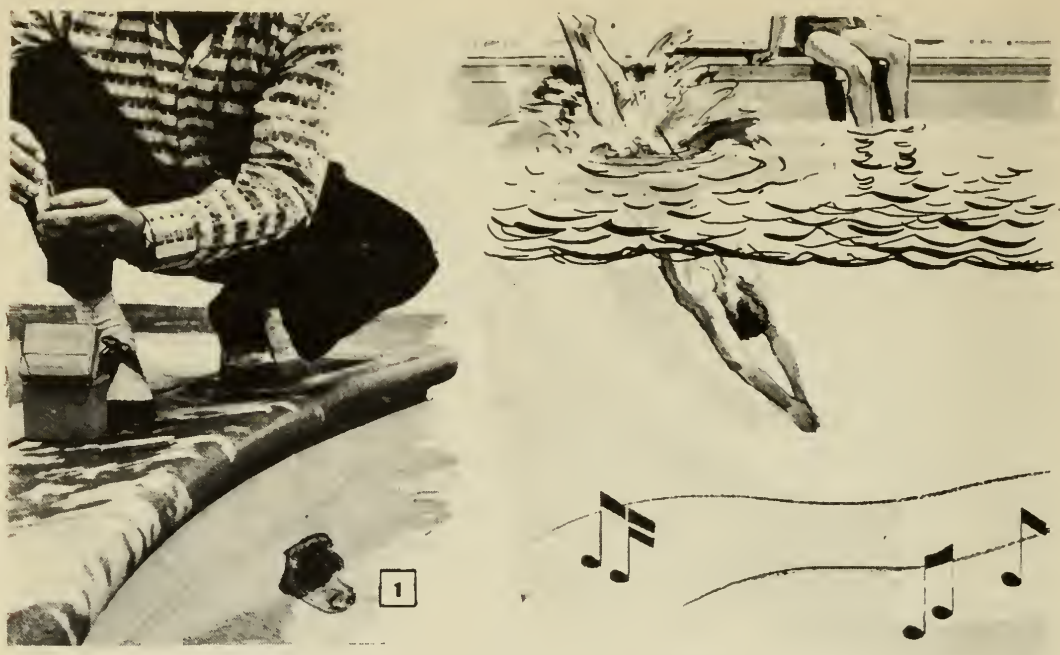


A recommended proportionate mix consists of portland cement, 1 part; sand, 2½ parts; and gravel, 3¼ parts. If the pool is to be plastered, the proportions should be as follows: portland cement, 1 part; and sand, 3 parts. Six gallons of water per sack of cement is about right. It is always best to pour a job complete at one time, but if this cannot be done, the joint should be roughened to assure a good bond and brushed with a soupy mixture of cement and water just before the pouring is resumed. Be sure that the concrete is well spaded in the forms with a long pole, to prevent air pockets and porous places in the finished wall. Also, avoid cave-in areas in the dirt walls, Fig. 4, detail B, which take considerably more concrete. Forms should not be removed for two or three days, after which the concrete should be cured gradually by wetting it frequently for several days. Dirt fill around the outside of the walls is packed solidly by wetting with a hose as it is shoveled in place, Fig. 4, detail C.

The nozzle from an old vacuum cleaner attached to a long pole will be found handy for cleaning the walls and bottom of a pool. Fasten it to a length of large hose and connect it to the suction-pump inlet, Fig. 11. Finish the walls and bottom of the pool with a couple coats of rubber-base paint. When cracks develop which cause serious leakage, they can be filled with asbestos roofing cement and then painted.





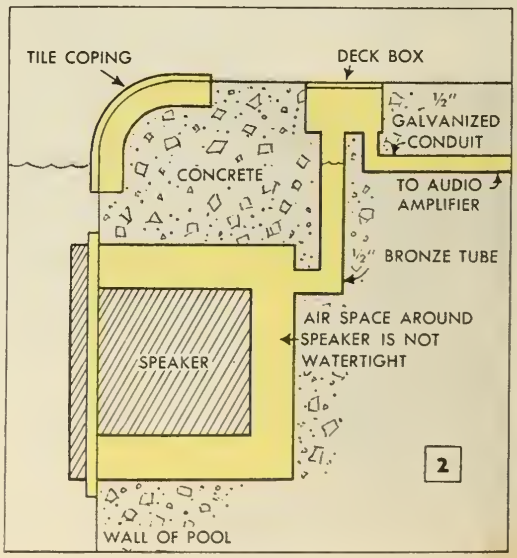


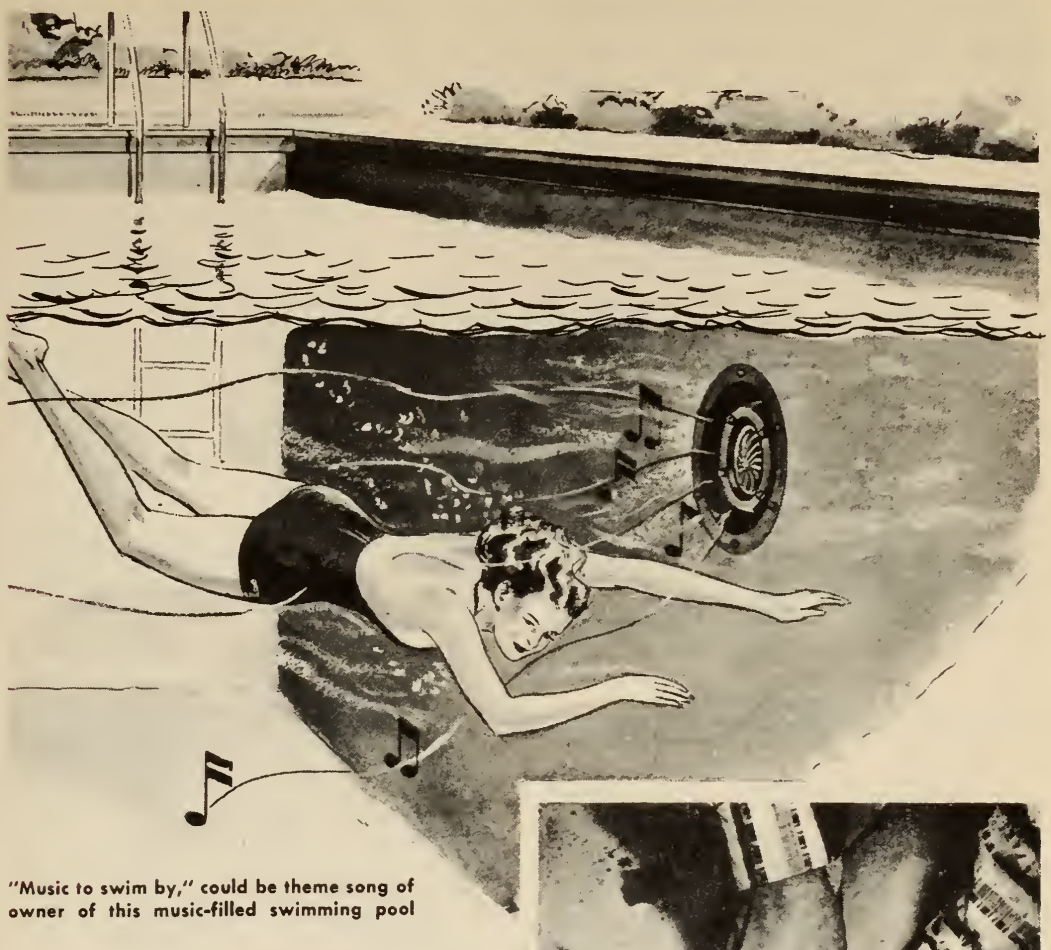
New Thrills With Underwater Sound

By James Joseph

YOU HEAR NO SOUND when standing beside this swimming pool, but dive into the water and immediately you are immersed in music. Frank O'Brien, audio engineer of Van Nuys, Calif., created this unusual condition by installing a loudspeaker under water. It is wired to an amplifier outside the pool. Because sound travels five times as fast in water as in air, and because other sounds are outside the water, music from the submerged speaker is more true-toned than one mounted in the air. The latter factors permit a single, fairly small speaker to fill even a very large pool with music. As an example of this, O'Brien used a single 30-watt speaker in an installation in a large hotel pool in Las Vegas, Nev.

The speaker used in each case is the type designed especially for use under water. In this type of speaker the diaphragm works directly against water pressure, as opposed to a regular speaker with a diaphragm that works against atmospheric pressure. A recess cut or cast into the wall of the pool, Fig. 2, is made 1 in. larger in diameter than the speaker and 1 in. deeper. The recess should be no more than 18 in. below the surface of the water. Below that level water pressure reduces the speaker efficiency. About 6 in. is a good depth. The flange of the speaker is screwed to a chrome-plated brass ring that is bolted to the surface of the pool wall. Although a Neoprene gasket is used to insulate the





"Music to swim by," could be theme song of owner of this music-filled swimming pool

speaker from the ring, no provision is made for keeping the speaker recess watertight. Used for the home-pool installation was a University MM-2F (UW) "submergence-proof" speaker. The warranty for the speaker applies only to intermittent submerging, but the original installation is still performing satisfactorily after several years. Cost of the speaker is about $40. From the speaker recess a ½-in. bronze tube leads up to a flush-mounted connector box in the pool deck above water level. Waterproof leads from the speaker are passed up through the tube and spliced to leads from the amplifier, the latter routed through a galvanized conduit buried in the concrete deck. Water from the pool fills the speaker niche and rises to its own level in the bronze tube, Fig. 2. To assure watertightness, before installing the speaker it is disassembled and the terminal connections waterproofed with a compound such as General Electric's Glyptol. The spliced wires in the connector box, Fig. 3, although above water level, also are waterproofed in this manner, in case that water runs into the box from the pool deck.

Another factor that must be considered with the speaker installation is the *pH* factor of the water in the swimming pool. Frequent testing, Fig. 1, is required to make sure that the factor is maintained in a range between 7.2 and 7.6. Excess acidity or alkalinity may damage the diaphragm of the speaker as well as cause corrosion in any exposed metal parts. So popular has underwater sound proved to be that several swimming-pool builders now offer it as an optional accessory. ★ ★ ★

Completed pool being enjoyed by whole family. Top layer of liner can be colored, slate-surfaced roll roofing

PAPER POOL FOR THE KIDS

IF ROOFING PAPER will keep water out, it should keep water in and Larry O'Rourke of Trenton, N. J., proved his point by using it to make a king-size wading pool for his kids for as little as $15.00. This paid for three rolls of 45-lb. asphalt roofing and a 5-gal. can of roofing cement, all that was needed to make a 15 x 15-ft. pool, 18 in. deep. The roofing, which should be the smooth-surface type, is used to make a "pie crust" liner inside a shallow excavated area in the yard. The dirt is piled around the edge to form a bank and tamped firm, after which the bottom of the excavation is covered with four separate layers of roofing paper. The strips of each layer are lapped about 6 in. and sealed with roofing cement. Each layer, in turn, is coated with tar and laid at right angles to the other. Separate strips are laid in at the corners. The important thing is to wind up with a watertight liner. Several large stones placed over the seams of the top layer will weight them to assure good contact. The edges of the layers are trimmed off evenly and then weighted all around the pool with large flagstones. It takes about 4 hr. to fill the pool with a garden hose and it can be drained in about 30 min. with a bucket and broom. Since freezing will not damage the pool, it can be partially filled with water during cold weather and used as a small skating rink.

Above, flagstones weight the edge of the paper liner and help decorate pool. Below, short-handle broom will be found handy for applying the roofing cement to the lapped roofing seams

TOTS' WADING POOL IS GLASS-LINED

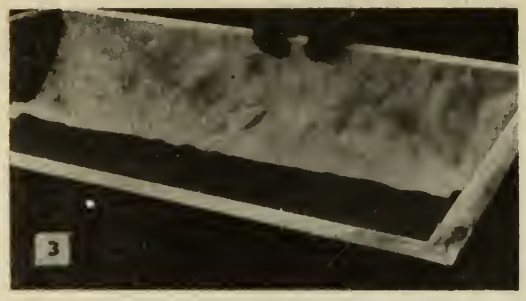
By V. Lee Oertle

HERE IS a glass-fiber-covered wading pool that will defy the roughest treatment your youngsters can give it, and still provide leakproof service with little or no maintenance for several years. The sturdy runners protect the bottom from damage and permit the pool to be pulled to any location desired. A few hand tools and a minimum of woodworking skill are all that is required to make this simply constructed pool. The runners, sides, ends and molding are cut from pine lumber and are assembled as shown in the drawing. Exterior-grade plywood is used for the bottom. All joints are glued and either nailed or fastened with screws. For easy draining, a sill faucet with threaded spout to take a garden-hose coupling is installed in one end of the pool as indicated.

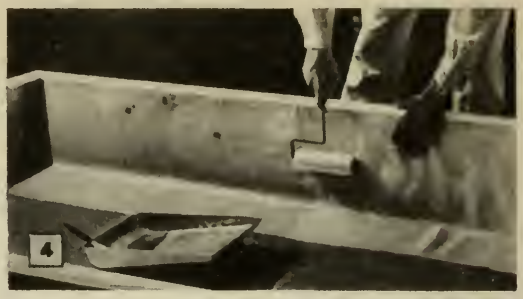
Applying the glass-fiber cloth is easy, when all the steps recommended by the manufacturer of the resin are carefully followed. First, cut the corner-reinforcement pieces and pieces for the ends, sides and bottom. Then, mix the hardener with the resin and cover one surface at a time as shown in Figs. 1 to 6. An overlap of at least 2 in. should be provided at each glass-fiber joint. All surfaces are primed and given two coats of marine paint.

After coating inside corner and adjacent top edge of side of wading pool with polyester resin, precut glass-fiber cloth is laid in place on corner edge

Application of inside corner strip of cloth completes corner reinforcement. All side corners are reinforced the same way, being sure to roll out air bubbles



Next, end and side pieces of glass-fiber cloth are applied one at a time as shown above. Each piece is cut and checked for proper fit before applying resin



Above, resin-saturated paint roller is used for removing bubbles and wrinkles from glass-fiber cloth, starting each stroke at top and working downward

Small paintbrush is handy for working resin-saturated cloth into corners where roller cannot be used. As with the latter, work in one direction

Bottom of pool is covered last. After coating plywood with resin, glass-fiber cloth is unrolled on it and air spaces are rolled out with paint roller

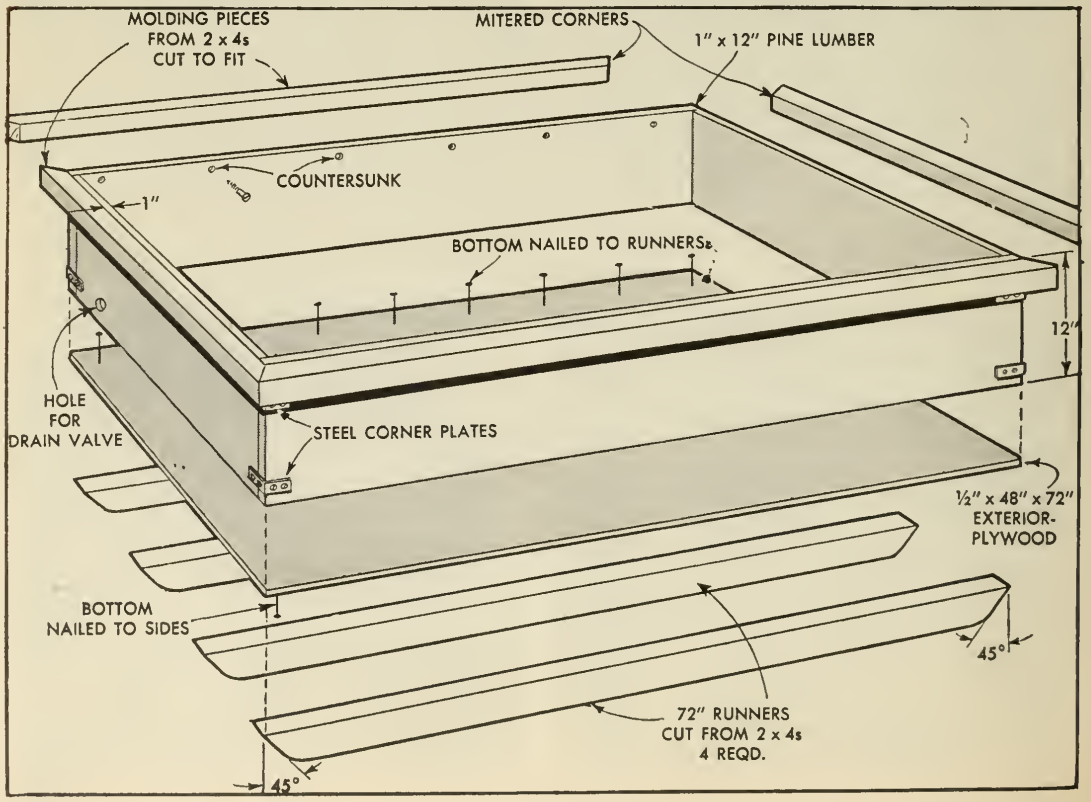


FIG. 1

Spacious breezeway between house and garage enables you to enjoy all the advantages of outdoor living during the warm summer months—including sleeping and serving meals. It also adds materially to the house value

Building and Remodeling

LOUNGING COMFORTABLY outdoors in a refreshingly cool breeze, yet shaded from the hot sun and screened from insects, is a luxury you can have by adding a porch or breezeway.

Size and location: A 9 by 12-ft. porch or breezeway is about the minimum satisfactory size for the average small home. Larger sizes are preferred usually, such as shown in Figs. 1 to 3. Where a porch is to be used frequently for serving meals, the most convenient location is alongside both dining room and kitchen. If a separate entrance to the kitchen is impossible, a kitchen window can be fitted with a drop-leaf serving counter as shown in Fig. 4. A full expanse of open sides on a porch gives maximum ventilation, but combination sash and screens permit using a porch during all kinds of weather.

Concrete and flagstone floors: A concrete slab floor, usually 4 in. thick, can be laid directly on compact, well drained earth, or raised a short distance above grade on a layer of coarse gravel or crushed stone. Forms are required at the edges only as shown in Fig. 4. The floor should have a drainage pitch of ¼ in. per ft., sloping away from the house, or toward one side of a breezeway.

When flagstone is used for porch floors, it should be imbedded in a 4-in. layer of concrete. Laying flagstones directly on the earth allows them to settle unevenly. Earth joints between flagstones also encourage the entrance of ants and burrowing rodents. Flagstone is rough and more difficult to keep clean than smooth concrete.

Where a slab floor must be laid over filled earth, which will settle, the floor should be supported on piers or on foundation walls resting on compact, undisturbed earth as indicated in Fig. 5. You can bore holes for piers with an 8-in. post-hole auger if the earth is firm. In sandy soil you can use sheet-metal furnace pipe for forms.

To prevent such a floor from breaking when a void forms under it because of settling fill, you reinforce it with ⅜ or ½-in. steel bars as shown in Fig. 5. These are laid at the center of the floor thickness, in both directions, and are spaced 12 in. apart. Such reinforcement also is required for

FIG. 2 Photo courtesy Andersen Corp.

concrete floors laid several feet above grade, over a crawl space, as shown in Fig. 6. The floor then is cast on horizontal forms adequately supported. An opening must be left in one of the walls to permit the forms to be removed. The foundation for such a raised floor should be of poured concrete.

In locations subject to heaving frosts, foundation walls, and also piers, should extend slightly beyond the depth of frost penetration. They should also rest on suitable footings. A footing 12 in. wide and 6 in. thick is sufficient for a foundation wall of an average-size porch not carrying added weight of a room above it. Where a concrete floor is cast against an existing concrete or brick wall, a non-extruding, asphalt-compound expansion strip, ½ in. thick, is inserted at the joint before laying the floor as indicated in Fig. 4.

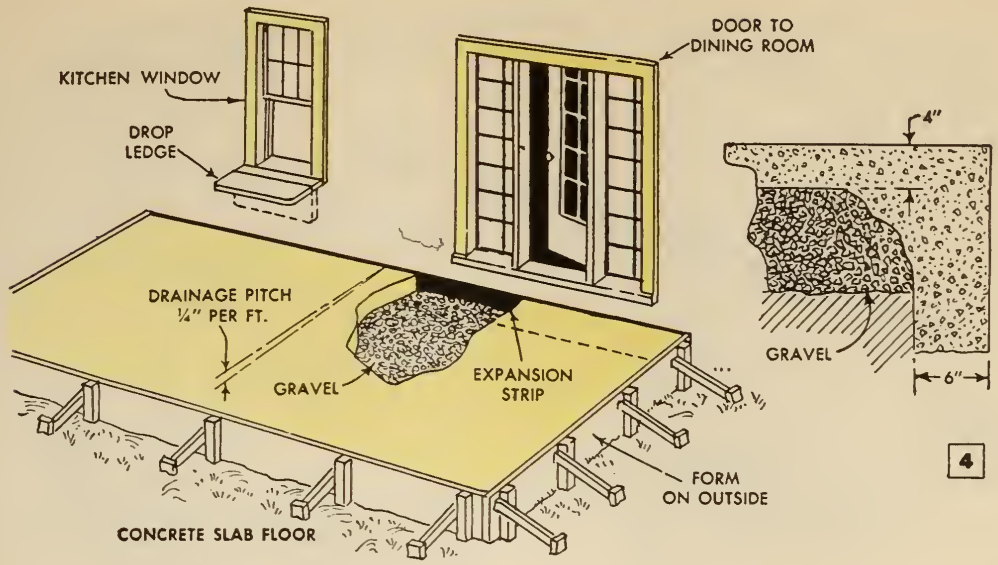
Foundation support for wood porches: The underfloor framing of a wood porch, Fig. 7, may rest on wood posts, concrete piers or foundation walls. When set into earth, concrete piers or footings are preferred to wood posts as these are subject to rot and must be renewed periodically.

For wood porches less than 2 or 3 ft. high, concrete piers usually extend up to the underfloor framing. Concrete piers, which often can be obtained ready-made, are 6 or 8 in. square, depending on pier height. Brick piers are 8½ in. or 12¼ in. square according to their height. Those of concrete blocks or hollow tile are 12 in. square.

Only hard, well-burned brick or tile should be used, for if the material can absorb moisture it will disintegrate upon freezing.

Footings under piers should be concrete, 12 in. square and 6 in. thick for small porches up to 6 ft. square. For medium-size porches, where the piers are not over 10 ft. apart, the footings should be 18 in. square and 8 in. thick. On large porches, where piers are spaced over 10 ft. apart, footings should be 24 in. square and 10 or 12 in. thick. Piers are located at corners and under the outer ends of one or more cross beams. The roof-supporting columns generally come over the pier positions.

Wood posts are satisfactory for use above grade. They should not be less than 5 in. square, and should rest on concrete footings projecting about 6 in. above grade. A



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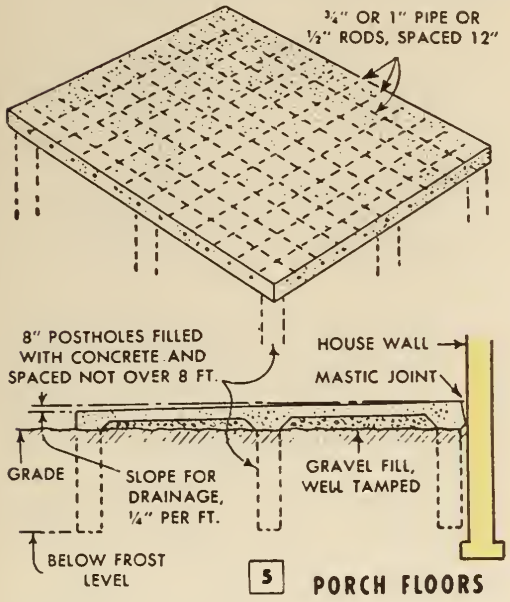
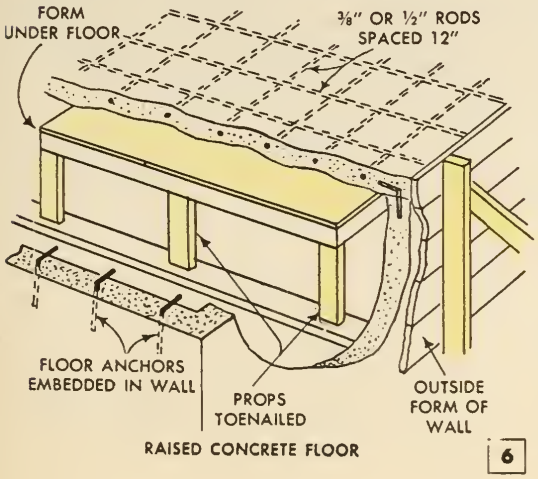


5 PORCH FLOORS



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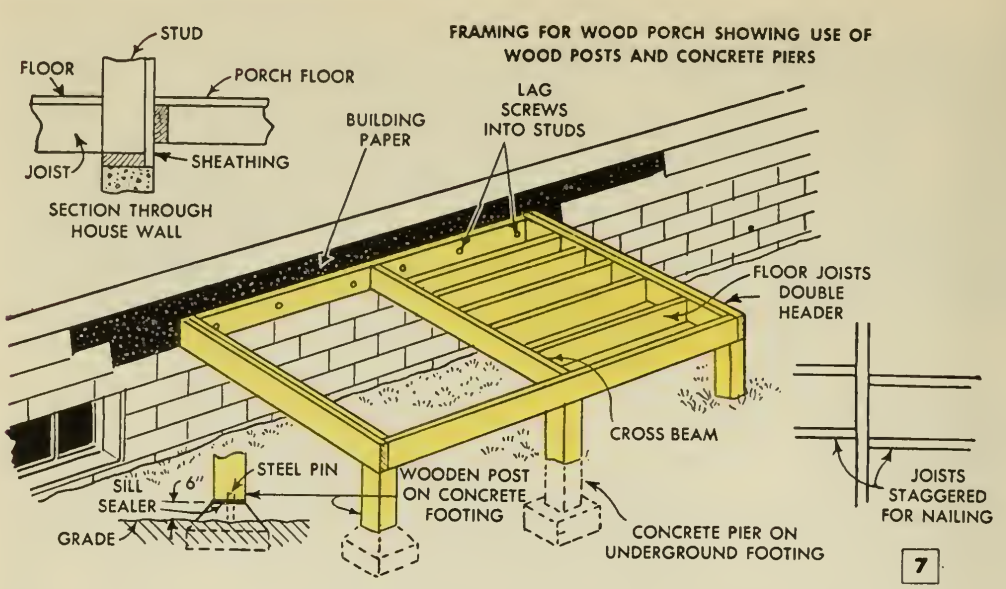
¾-in. steel pin cast in the center of each footing fits a hole centered in the bottom of the post to keep it in place. After treating the lower end of the post with wood preservative, a piece of asphalt-compound, sill sealer, ½ in. thick, is placed between the post and footing. This material conforms to surface irregularities when subjected to pressure, and keeps water away from the wood. California redwood, red cypress and western red cedar are the most decay-resistant woods. If less decay resistant wood is used, it should be treated with wood preservative, preferably the kind that will not bleed after subsequent painting.

Floor framing: To install floor framing it is necessary to remove a section of siding, some shingles or stucco as shown in Fig. 7, but not the sheathing. Then you attach a full-length joist, using nails or lag screws driven into studs. The removed wall covering is later restored to floor level. On brick and stone walls the joist is attached with lag screws driven into expansion sleeves fitting holes drilled in the mortar.

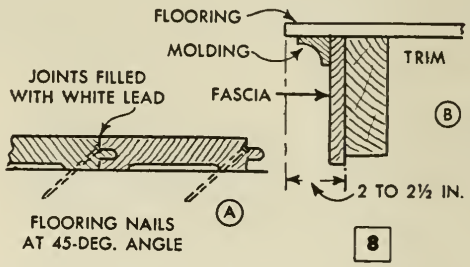
As flooring of a porch should be laid in the direction of drainage, the joists are usually run parallel to the house. Greatest rigidity is obtained with relatively short joist spans between double end headers and one or more cross beams, as shown in Fig. 7. The headers and cross beams are nailed to the joist that is already fastened to the wall. The cross beams may be held to it with iron stirrups. The installation of bridging between floor joists increases their rigidity. After outer framework has been completed, the joists are spaced on 16-in. centers, and end-nailed with 20-d. nails. Joists on either side of the beams are staggered to permit end nailing. For spans



of 8 ft. or less between supports, use 2 by 6-in. framing members. Stock of 2 by 8-in. size is needed for spans from 8 to 12 ft. The framework is given a slight slope of ¼ in. per ft. away from the house so water will drain readily.

Flooring: Matched tongue-and-groove porch flooring, preferably heartwood, which is most resistant to decay, is nailed across the joists and to each one. To keep water out of the tongue-and-groove joints you seal them with white lead and force the flooring together tightly before nailing it. Aluminum flooring nails do not rust. Drive the nails at a 45-deg. angle at the base of the tongue as in Fig. 8-A, and sink the heads with a nail set. Flooring should extend about 2 in. beyond the framework as in detail B. Let random ends project beyond this distance, then mark and cut off straight, after which the fascia and molding are applied to conceal the framework. The trim is mitered at corners.

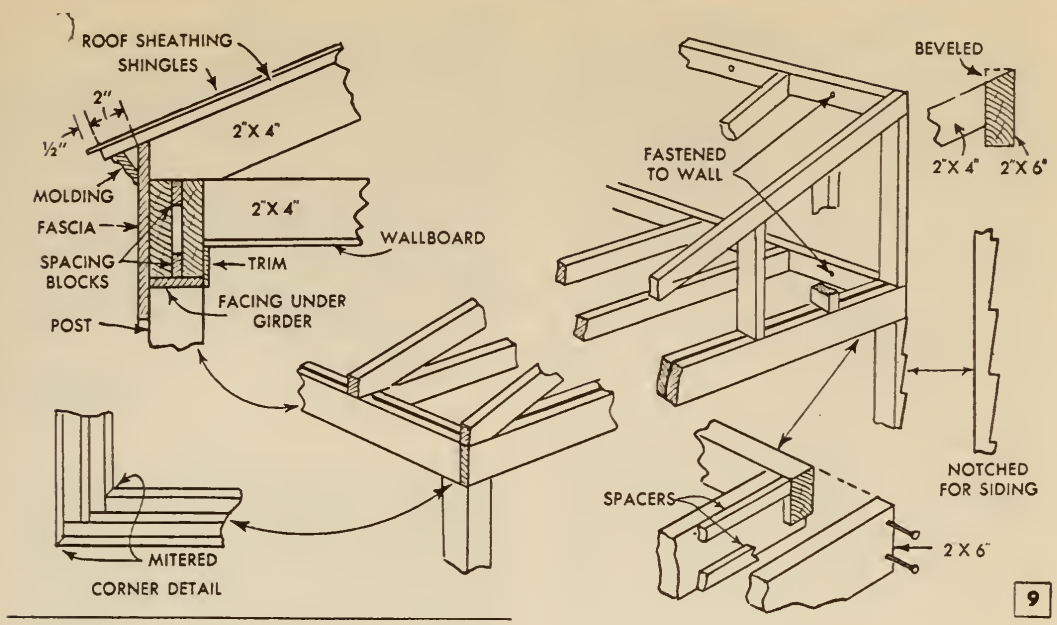
Framework for ceiling and roof: Fig. 9 shows how the framework for ceiling and roof can be assembled. Floor-to-ceiling height should not be less than 7 ft. Often a porch roof is built on temporary supports later replaced by permanent posts or columns, after framing is completed. However, the permanent posts may be installed at the start. You start the top framing by attaching a header to the house wall in the same way as the first joist of the floor framework was attached. The girders are temporarily braced while nailing them together and to the header. The underside of girders is covered with a facing piece of equal width. Girders for small porches may consist of two lengths of 2 by 4-in. stock, but 2 by 6-in. stock is preferred generally for medium-size porches. For greatest strength,

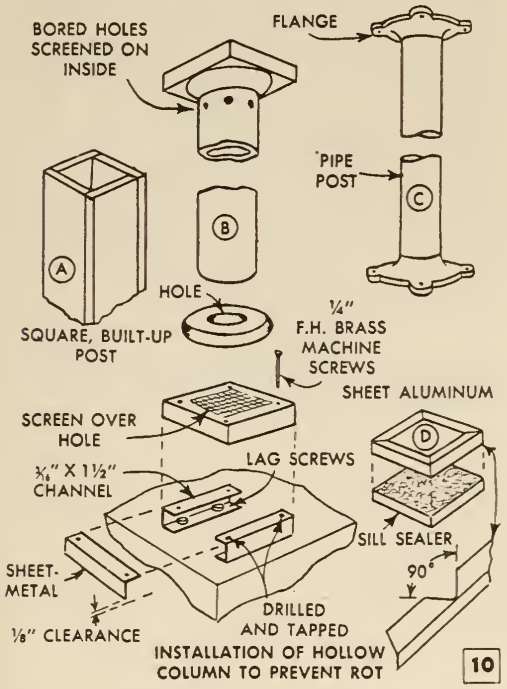


and to prevent any sagging of girders where they span posts, they should be set edgewise. They are nailed together or to spacing strips or blocks between them to make the girder width equal to or greater than that of the post.

After erecting the girders you install the ceiling joists. As these usually carry no weight other than that of the covering material nailed to them, such as wallboard, 2 by 4-in. stock generally is suitable for spans up to 10 ft. The joists can be toenailed to the header and girder, flush with the top edges of these. Ceiling joists, rafters and studs are usually spaced 16 in. on centers, starting from one end.

Roof-supporting posts: Solid wood posts, 4 to 6 in. square, are generally used to support porch roofs. Hollow wood posts may be built up square or round as shown in Fig. 10-A and B, or steel pipe can be used, fitted with floor flanges as in detail C. Hollow wood posts and columns should be ventilated by providing screen-covered holes at the top and bottom as shown in detail B. Here the column base is elevated on nonrusting metal angles to keep the wood dry. Another way to do this is to mount the post on a ½-in. asphalt-compound sill sealer as in detail D, which also prevents the post from absorbing water on the floor. For ap-





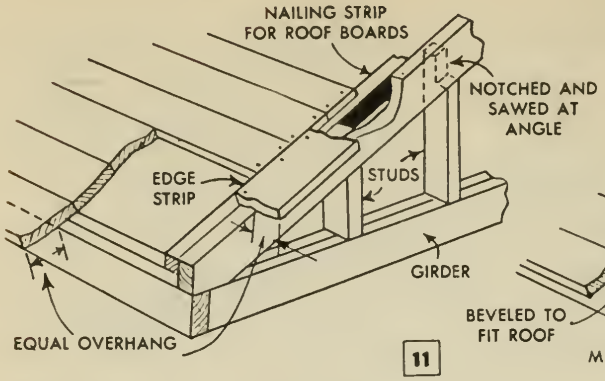
pearance the sill sealer should be covered with sheet-aluminum as indicated. In both cases the lower end of the post or column is first treated with wood preservative for added protection.

If you want to use steel pipe for posts as in Fig. 10-C, the 2-in. size (inside diameter) is adequate for the average 9 by 12-ft. porch where posts are not spaced over 6 ft. apart. The pipe is threaded at both ends for flanges, which are screwed in or out to obtain the exact length desired. The flanges are screwed to wood and are attached to concrete by means of lag screws fitting expansion sleeves in holes that are drilled in the concrete. For porches larger than 9 by 12 ft., and for greater spacing between posts, pipe of larger diameter is used. The posts are arranged to come inside of the screens generally.

Roofing a porch: A shed-type roof, such as shown in Figs. 9, 11 and 12, is easiest to build. It consists of a header attached to the house. Rafters are toenailed to the header and girder after being cut to size and at the correct angles at both ends. If rafters extend beyond the girder, they are notched to fit it. The end rafters are aligned with the side girders.

Nail roof boards and edge strips to the rafters as in Fig. 11. Enclose the wall sections between side girders and end rafters, and apply trim as in Fig. 12. This illustration shows how exterior-type wallboard can be used. In the example shown the fascia closes the opening between the ends of the rafters. In gable and hip-type roofs the rafters next to the house are attached to it.

Start the shingling from the lower edge of the roof, using a double layer for the first course. Let the shingles overlap the roof boards approximately ⅜ inch. You install flashing between the porch roof and the house wall as shown in Fig. 13. Detail A shows flashing under siding and over shingles of a shed-type roof. Detail B shows how flashing is imbedded in mortar between courses of bricks. Where the porch roof has a slope along a brick house wall, double flashing is installed as shown in detail C. An enclosed space between a porch ceiling and roof should be properly vented. Insulation over the ceiling or under rafters will add materially to comfort.



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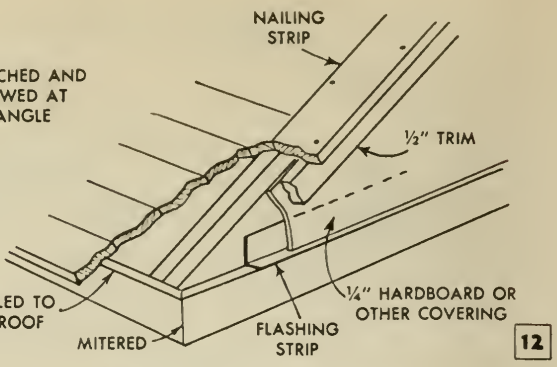


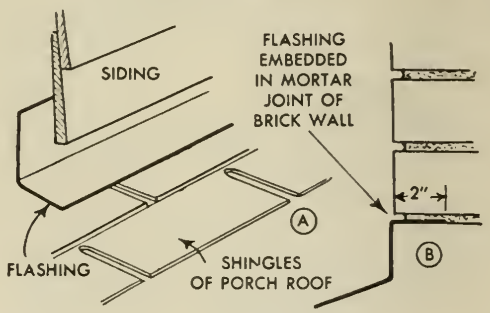
12

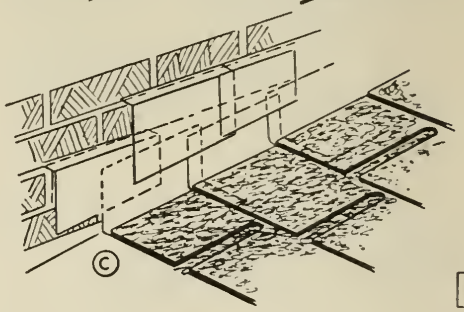
Breezeway framing: On most breezeways the roof is supported by two parallel girders along the sides, which are usually double thickness. One end of the girders often rests on the top plates of the garage wall, for which the garage roof must be opened and altered as necessary to join the roof of the breezeway. At the house end, the wall usually is opened and a header is attached to studs in the same way as is illustrated in Fig. 9. Where the girders are long, the ceiling joists or rafters are installed at right angles to the girders. For short spans, however, the joists can be run parallel to the girders. If the roof is flat, with a slight slope for drainage, the ceiling can be applied directly to the underside of the rafters. If the roof is of the gable type, ceiling joists are required to have a horizontal ceiling.

Canopies: Colorful, waterproof, canvas canopies are fitted on a framework of pipes to which they are lashed, besides being suitably fastened at all edges. Because of constant weather exposure canvas canopies will last much longer if they are taken down and stored during inclement winter weather in northern climates. This entails the semiannual trouble of dismantling and erecting them. As constant exposure to weather deteriorates the fabric, canvas canopies require periodic replacement.

As they are practically indestructible under normal conditions of use, permanent sheet-metal canopies require no further attention, once erected. They are prefabricated in various style and sizes, from small door canopies to large patio roofs. Those made of aluminum, like the one shown in Fig. 14, are lightweight, rustproof and extremely rigid. Designed for easy installation, they come in kit form, which includes the framework and the cover sections, but not pipe or ironwork supports. After assembling the frame, Fig. 15, and attaching it to the house wall and to the supports, the cover sections, which come in baked-enamel finishes, are screwed in place.

Wood steps: Construction of wood steps,





13

often used on wood porches that are several feet above grade, is shown in Fig. 16. The treads are divided for drainage. Grooved rails that accommodate square balusters are available at most lumber dealers. Balusters are spaced with insert pieces nailed to the railing.

Concrete steps: For permanence, you can build concrete steps as shown in Fig. 17. They will not be subject to settling nor to damage from heaving frosts if they have a 6-in. foundation wall extending just below frost level. In sandy soil a double form is needed for the foundation wall, but where soil is stiff enough to resist caving, an inner form is usually sufficient. After the foundation has hardened, you fill the hole and build the form for the steps. Note from Fig. 17, that tie strips are located well above the edges of the form boards to allow room for finishing the concrete surface with a trowel and edger. Treads should be 10 to 11 in. wide, and the step height should be about 7 in. Slanting the risers inward 1 in. at the bottom provides added toe space. In this case the lower edges of the riser forms

FIG. 14

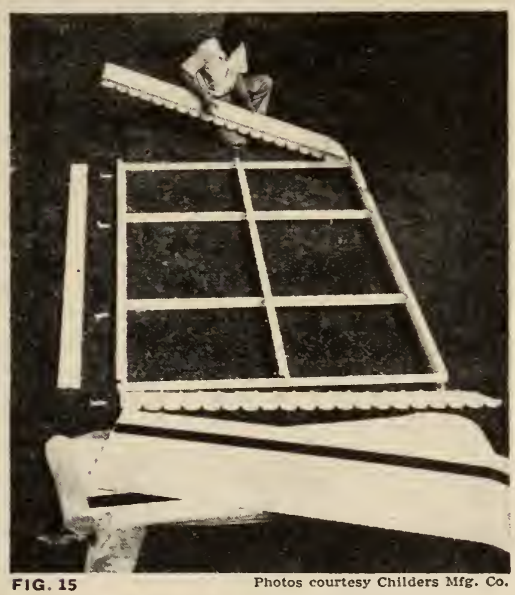
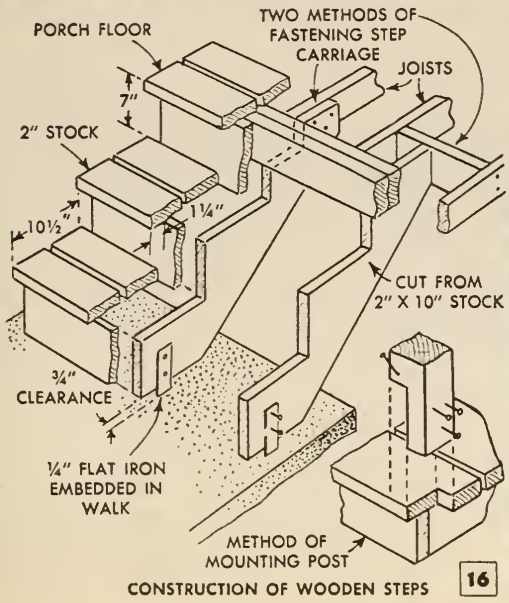


FIG. 15 Photos courtesy Childers Mfg. Co.



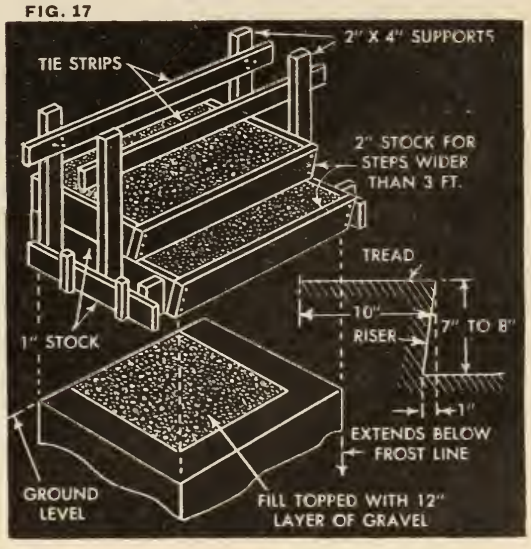
CONSTRUCTION OF WOODEN STEPS 16

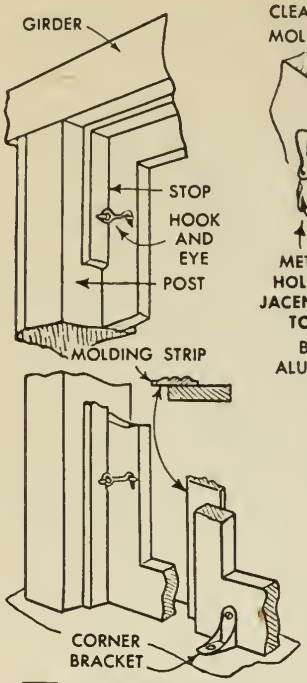
should be planned at an angle to fit flush with the tread surfaces. To prevent the concrete from bulging up at the open treads when the form is filled, lay and weight down wide boards temporarily across the form. Remove these as soon as the concrete sets in order to trowel the surface smooth and round the edges of the treads with an edging tool.

Fitting screens: For substantial screen frames, use 1⅛-in. stock. Cover the frames with non-rusting screen. This is the most economical because of its durability, even though the initial cost is higher than that of usual wire screen. Customarily screen frames are held in place as shown in Fig. 18, using hooks and eyes on one side and stops on the other where frames are joined to square posts. Where the frames are butted together, a strip of molding is used on one side and turnbuttons on the other to hold the frames in alignment. The frames usually rest on the floor or on a sill to which they may be hooked also. When retained in a grooved sill, the frames are subject to constant wetting, which hastens decay.

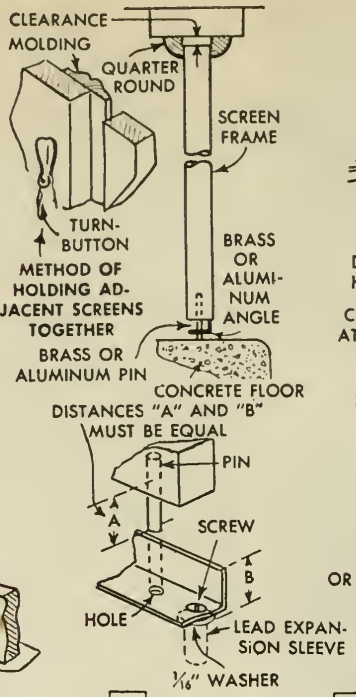
An arrangement that prevents direct contact of the screen frames with the porch floor, and thus prevents frequent soaking, is shown in Fig. 19. Notice the slot between the members of the top plate into which the frames are pushed before they are let down on the metal sills. These consist of ⅛ by ⅛ by 1 or 1¼-in. angles of brass or aluminum. The sills have drilled holes in which pins on the frames fit. The frames also rest on the angles. To allow for drainage the angles are shimmed up about 1/16 in. above the floor by means of washers under them and over screws that are used for attachment. Adjoining frames are held together by means of molding strips on the outside and turnbuttons on the inside.

FIG. 17





18 USUAL METHOD OF FASTENING SCREENS



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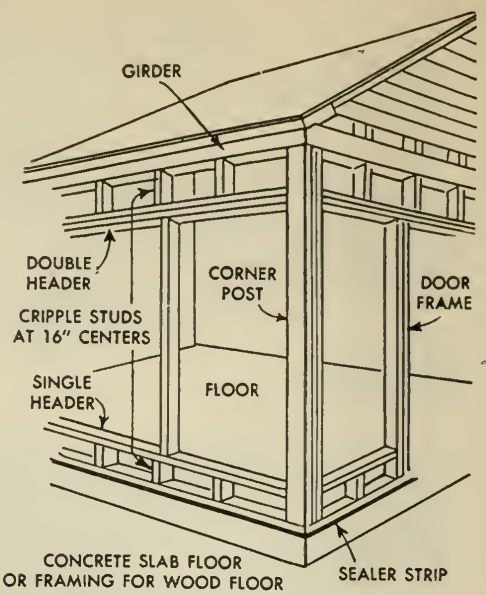


20 FRAMING PORCH WALLS FOR PERMANENT WINDOWS

Enclosing a porch: You can get year-'round usefulness from a porch by installing permanent windows as shown in Fig. 20. For maximum ventilation use windows of the type that can be fully opened. Ordinary double-hung windows do not provide an unobstructed opening more than 50 percent of the window area. The floor, ceiling and walls should be insulated. Windows should be weatherstripped and provided with storm sash in cold localities, or you can install insulating-type window panes—the kind having two layers of glass hermetically sealed together, with an air space between them.

Steps of procedure: Before you enclose a porch be sure that a wood floor is level and walls plumb. A concrete slab floor in good condition should have adequate support of piers or a foundation wall set below frost level. Perimeter insulation should be installed on the outside of an existing concrete floor, in localities subject to cold weather.

In case of a wooden porch, you first examine the floor and framework underneath it, replacing any unsound or defective portions. Most wooden porches supported by posts or piers not properly installed will settle in course of time. A sagged porch must first be jacked up slightly above level to that it can be let down on new piers set on substantial footings as previously discussed. Termite shields, if necessary, are placed on the piers before the floor framework is let down. Wedges, such as cypress shingles, may be needed for leveling the porch on the piers.

Where a wooden floor is in good condition, it may be left intact, but insulation and a vapor barrier should be provided under the floor as explained on page 1152. An existing floor or a new one should come flush with the outside edges of the floor framing. Next, you temporarily support the roof girders by securely wedging 2 by 6-in. planks between them and the floor. Raise the girders slightly so that the posts or columns can be removed unless they are to become part of the new wall.

To build the wall framework as shown in Fig. 20, you start by installing 2 by 4-in. sole plates laid on ½-in. sill-sealing strips. Fasten the plates to the underfloor framing with 16-d. nails, or to a concrete slab floor with lag screws and expansion sleeves. The corner studs, arranged as detailed in Section 7, are next. Toenail them to the sole plates and girders. Then remove the temporary girder supports and finish the framing, spacing the studs at 16-in. centers. Nailing bases must be provided for the inside wall covering.

SCREENED FOR COOL RELAXATION

By Hi Sibley

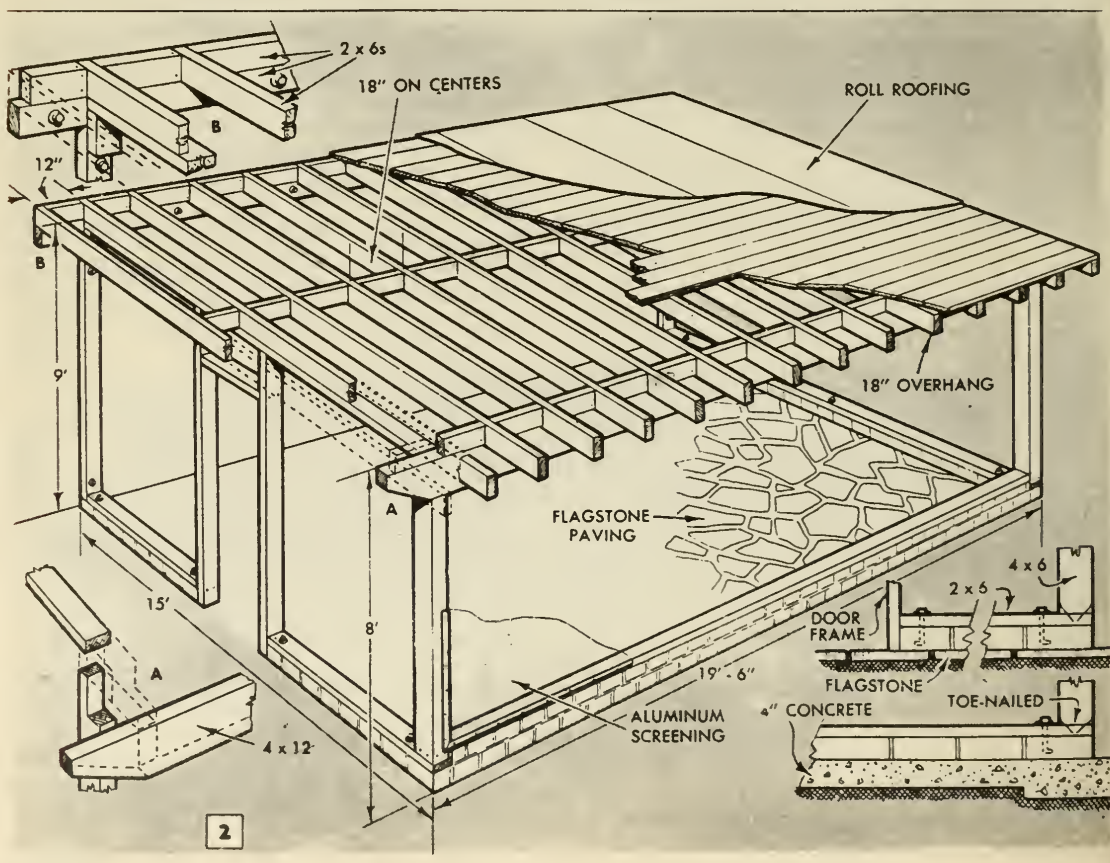
PORCHES AND OTHER screened-in areas have in the past had a "cluttered" appearance because of the need for many narrow screen panels. This was necessary because screening was available only in fairly narrow widths. Aluminum screening now can be obtained in 72-in. widths, which means that an opening to be screened can be just 1 in. less than 6 ft. in height. The length of any such opening is limited only by the restrictions of safe, strong construction. For example, the opening in the screened addition in Fig. 2 is almost 19 ft. long. Because the ends of the structure are more than 6 ft. high, due to the required slant of the roof, the screening on them is positioned vertically. The width of these panels, however, can be up to 6 ft., to maintain the "picture window" effect.

Fig. 1 illustrates a screened-in addition that was built over a flagstone patio which had been laid some years earlier. Concrete blocks were mortared to the flagstones, then filled with concrete in which several anchor bolts were positioned. A 2 x 6 sill plate then was drilled to fit over the bolts. Instead of concrete blocks, a concrete footing could be poured, with forms above ground, to provide a low wall. Or a footing flush with the ground could have a brick or concrete wall built on it. It is not advisable to have lumber directly on the ground because of the moisture problem. Although the details in Fig. 2 show the 4 x 6 corner posts to be toe-nailed to the sill plate, it actually would be easier to build the end walls complete on the ground, then have a friend help you raise them into position. Nails could be driven up through the sill plate into the columns. The frame member next to the house is drilled for lag or anchor bolts. Their locations are marked through the frame member, and the wall is moved aside while the holes are drilled and the anchors inserted. The wall framing then is fitted on the foundation and against the house wall, and bolted in place. Note in the detail in Fig. 2 that the 4 x 6 end members of the frames are half-lapped to accept the 4 x 12 timber that spans the length of the room addition.

The end walls now are plumbed and the 4 x 12 is spiked to them. A 2 x 6 is fastened to the house wall to support the inner ends of the roof rafters that are fitted next. The outer ends of the rafters, of course, rest on the 4 x 12. Spacers, or bridging, between the rafters could be offset so that it would be possible to nail through the rafters into them, instead of being aligned as shown in Fig. 2. A roof overhang of 18 in. is indicated, but this could be decreased or increased somewhat to suit. Before installing the screening, all wood should be stained or painted. The framing should be allowed to settle before the screen is attached permanently, so staple or tack the material just enough to hold it in place, if the room is to be used immediately. Half-round molding is used to cover the edge of the screening, but this also should be fastened temporarily, so it can be removed easily. After the framing has settled thoroughly (the screening will sag and bulge

Wide-open view on all sides of this room addition is result of using 72-in.-wide aluminum screening

Detailed below is a suggested design for a screened-in room addition that utilizes aluminum screening available in 72-in. widths. Shown in Fig. 1 is an actual structure using this design. Whether the scene is mountains, as above, or just an attractive back yard, the view is unobstructed by any framing members



Wide aluminum screening permits use of large screen panels that can be removed, replaced with windows

as this happens) the molding is removed and the screening loosened. It then is stretched tightly and tacked or stapled at close intervals. Replacing the half-round molding completes the job.

In Fig. 5 is illustrated another room addition where the wide screening has been used, but the openings have been reduced by the use of vertical and horizontal framing. The use of this framing was for appearance, to keep the room architecturally compatible with the house. Note also that the foundation wall is both block and poured concrete, to match the house. Figs. 3 and 4 show freestanding structures that have been screened. Taking advantage of the wide screening, the panels are large, but still are removable. This setup also could be used on such structures as screened-in porches that are closed in with storm windows for the winter. Because aluminum is rustproof, the screens could be left in place all winter, with the windows fitted inside them, or even outside if necessary or desirable. This would eliminate the storage problem presented by the large screens.

Although the screened room addition in Figs. 1 and 2 has a flat roof, it must be kept in mind that this would not be practical in an area of very heavy snowfall. In these areas more pitch is required in the roof to reduce the effect of a snow load. Also, the corner posts, as well as the long beam between them that supports the outer ends of the rafters, might have to be heavier to accommodate the greater weight of the snow. Roll roofing would be adequate in most instances, but shingles could not be used unless the roof had at least a moderate pitch. In all cases it is advisable to have a room addition designed to be compatible with the architecture of the house. What looks well beside your neighbor's house might be an eyesore next to your home. ★ ★ ★

Another structure that takes advantage of the wide screening to provide open view, improve appearance

Made unnecessary by wide screening, cross members in these screened walls are for appearance only

ENCLOSE YOUR FRONT PORCH

Packages too large for the mail drop can be placed in the milk compartment. Label compartment to indicate use

IF YOUR HOUSE has an open front porch, enclosing it in glass will bring several distinct advantages. First, it will be an additional room — year-round, if heated, or comfortable for many extra weeks before and after the summer season, if unheated. In addition, it will serve as insulation, keeping the adjacent rooms of the house warmer in winter and cooler in summer. And, finally, it will improve the appearance and value of your property.

As every porch presents its own peculiar problems, it is impossible to give complete directions for enclosing any particular porch. However, you will find that most of the details and general dimensions given in the story are applicable to your own porch with very little modification. In addition to these details, you also will find cabinets that facilitate the delivery of mail, newspapers, milk and packages.

The first consideration in making the enclosure is adapting the original columns for the installation of the window frames. Although the columns sometimes can be squared-up by nailing boards to them, the best procedure most often is to replace them with square posts. Make the posts

Photo above shows porch with original round columns. Note in left-hand photo how old columns have been replaced by square box-type columns to facilitate window framing. Doorway has been rough-framed with 2 x 4s. Window frames are already installed on the side

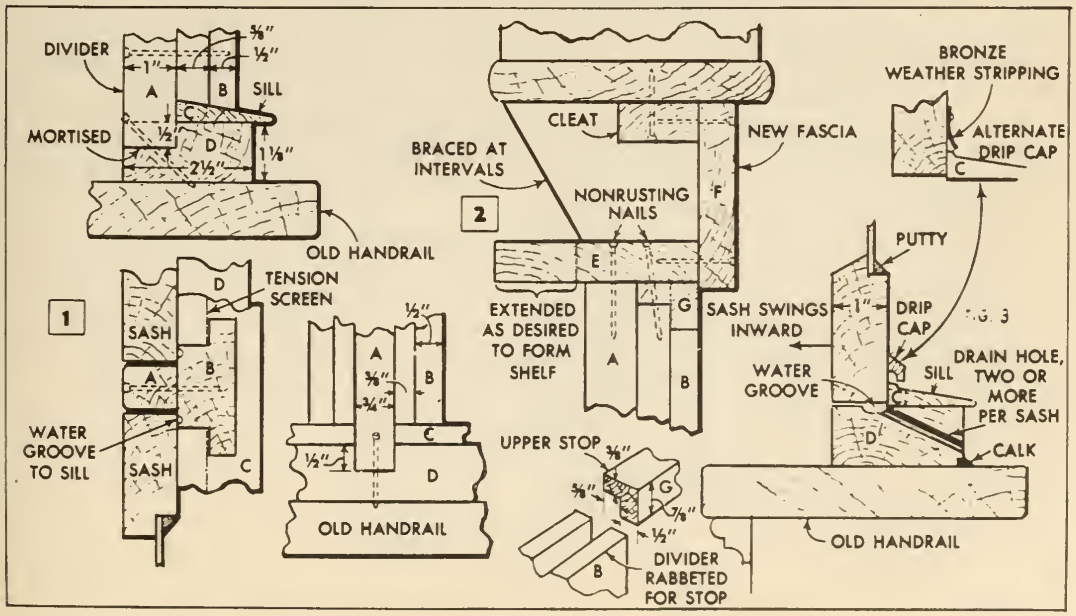
Here's how newly enclosed porch looks from the outside. Compartments flanking door make neat arrangement

from 1-in. lumber, as in the photo above Fig. 3, applying water-resistant glue to the joints and using nonrusting nails to fasten them together.

Although you can enclose your porch with almost any type of glazed unit—anything from double-hung sash to storm doors—the least expensive way is to make your own sash. Single-pane casement sash are the simplest to make, and these are hinged to close into frames made as in Figs. 1 to 3. The sash should be made of lumber at least 1 in. in actual thickness with the corner joints mortised and tenoned, as in the photo on page 1828.

If the original handrail is in good condition, the window frames can be built up from it. Although the length of the

New square columns to replace round ones are made as above



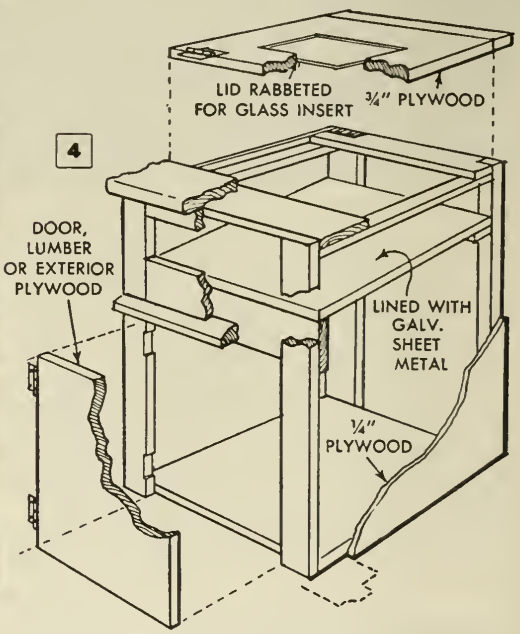
Corner joints of window sash are mortised and tenoned as above. Inside edges are rabbeted for pane

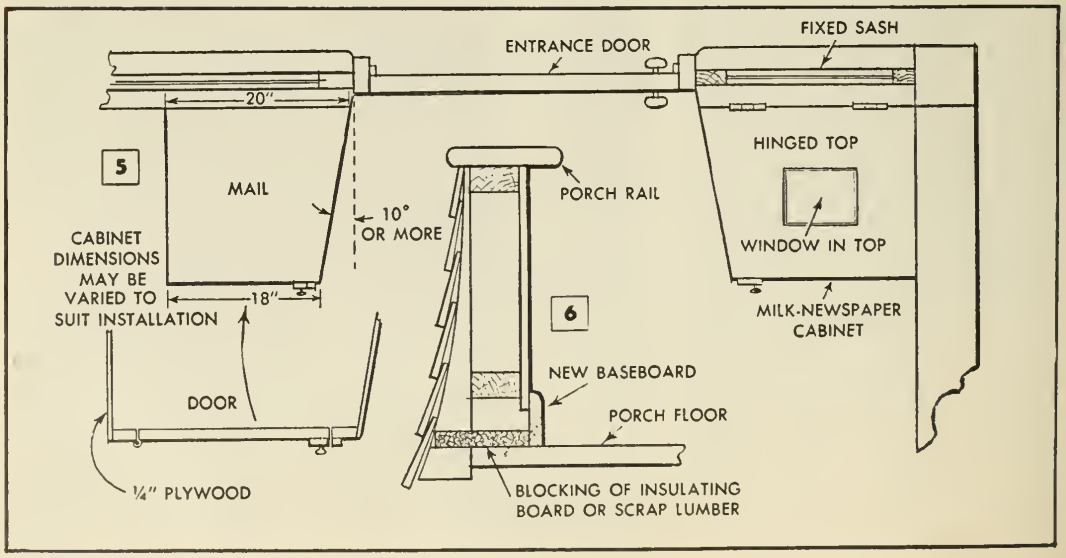
Photo below shows how sills directly above compartments are fitted with triangular-shaped blocks to drain water away from compartment door. See Fig. 7

frame members will vary according to the size of sash used, the dimensions given in Figs. 1 and 2 may be used in all cases. Note that the various parts are keyed so they may be identified in each of the drawings.

A new fascia, detail F in Fig. 2, is added, its width determined by the particular installation. Several vertical braces should be added at intervals to strengthen the framing, and the horizontal board, detail E, may be ripped to fit almost flush with the face of the sash or left wide to form a shelf.

The water grooves cut in part B, Fig. 1, together with the water groove and drain hole in part D, Fig. 2, combine with the drip cap to make the sash watertight. Apply calking compound around all fixed sash





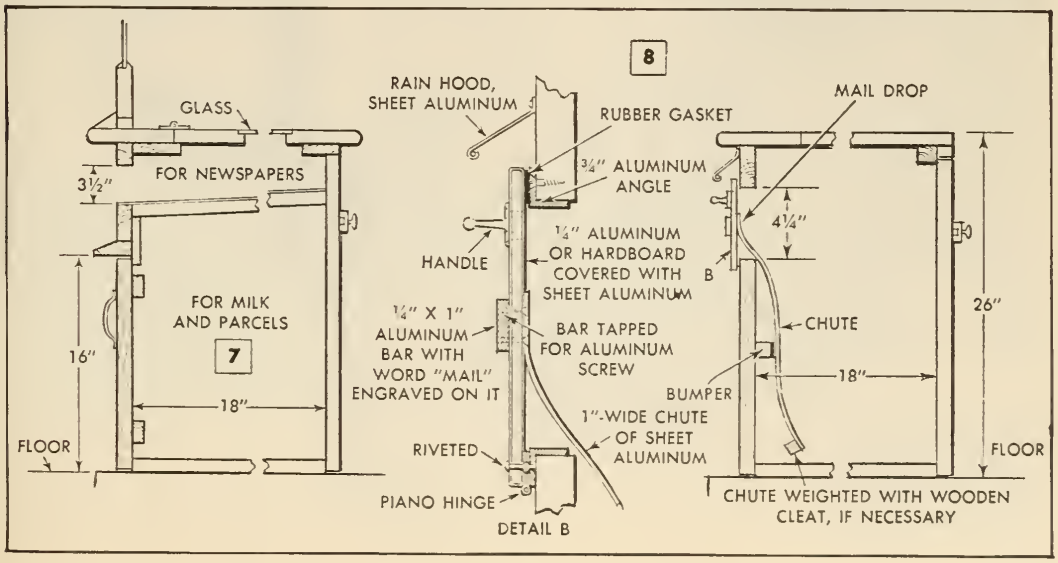
Partially finished newspaper-milk compartment is shown at left. Photo at right shows finished compartments

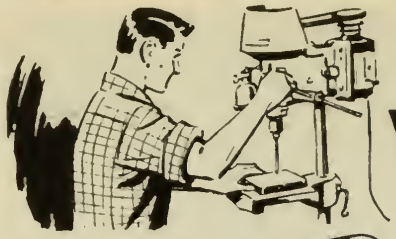
and at any other points where water may enter.

Figs. 4 to 8 detail the compartments which may be built on both sides of the entrance to simplify deliveries. One, detailed in Fig. 7, has a special slot for newspapers and a cabinet for milk and parcels. The other, Fig. 8, consists of a mail drop and chute. Both compartments are fitted with doors for easy access from inside the porch. Construction of the cabinets is simple, as shown in Fig. 4, although dimensions and even the design given for this particular installation may have to be varied. The mail-drop opening is 4¼ x 11½ in., with a usable height of 3¾ in. because of the chute.

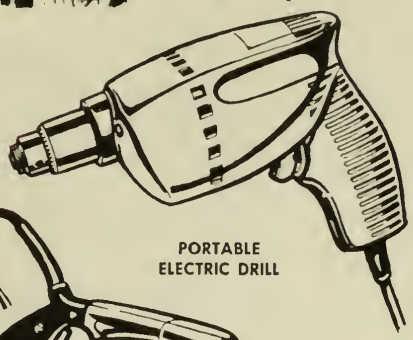
Even though the original porch rail is covered with siding, you probably will find that it was provided with drain openings near the floor. These can be sealed with a blocking of thick insulating board or lumber, as shown in Fig. 6, and the addition of a new baseboard. ★ ★ ★

Sheet-metal mail chute is formed as above

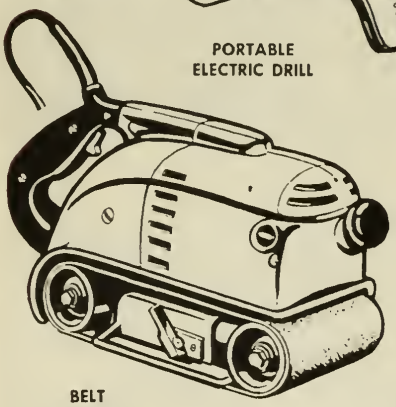




HOW TO CHOOSE YOUR POWER TOOLS



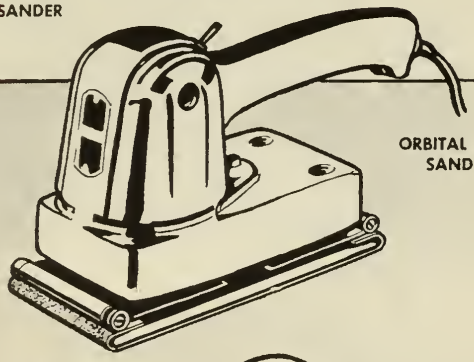
PORTABLE ELECTRIC DRILL



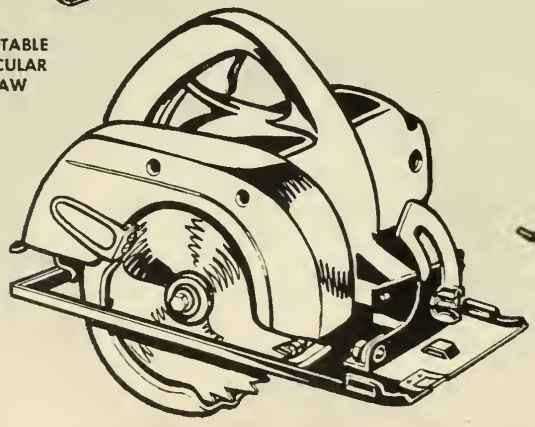
BELT SANDER

IF YOU EQUIP YOUR SHOP with the portable electric tools shown on this page, you can do the common power-tool operations, such as squaring and ripping stock to size, jigsawing scrollwork, drilling, dadoing, and the rough and finish sanding preparatory to finishing the project. That about covers construction of home built-ins, small-boat construction, building a garage or making outdoor furniture. But for cabinetmaking you'll need supplementary hand tools to cut mortises, plane stock to such thicknesses as may be required and joint edges true for gluing stock to wide widths.

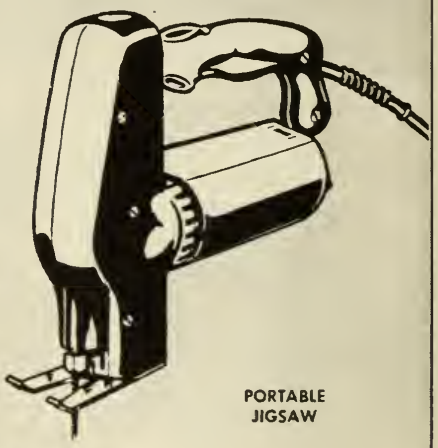
One feature of all portable tools, that is, those which are held in the hand when operated, should be kept in mind when planning your shop equipment: the portable power tool is carried to the work. This can be an important time, step and space saver when your shop is small, when the job calls for cutting large sheets of plywood or similar materials, or where the project is being built at some distance from



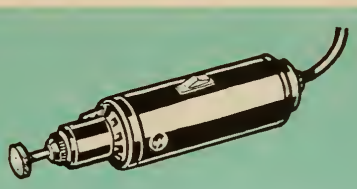
ORBITAL (PAD) SANDER



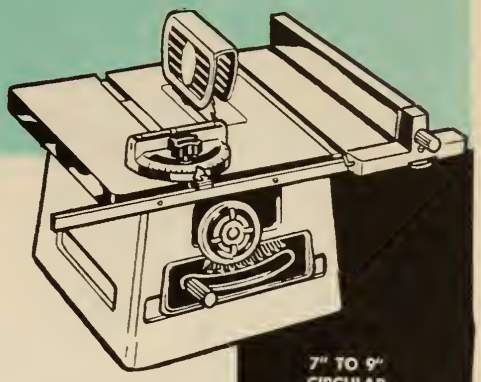
PORTABLE CIRCULAR SAW



PORTABLE JIGSAW



HIGH-SPEED
HAND GRINDER

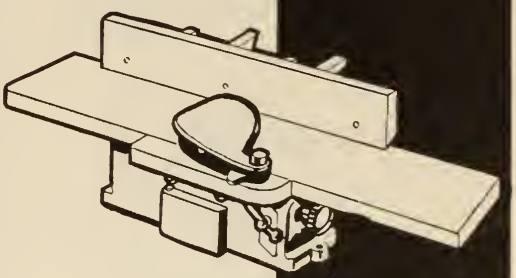


7" TO 9"
CIRCULAR
SAW

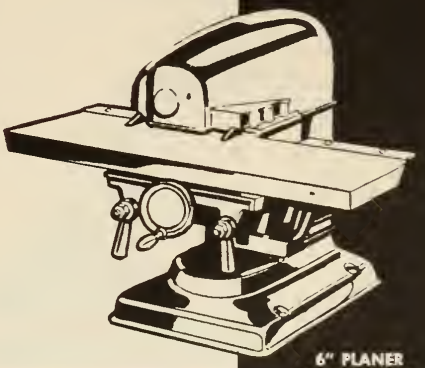
the shop. Another point in favor of portable tools is the small space required for storing the units when not in use.

Three of the tools shown — the hand grinder, portable drill and circular saw— are available with a range of accessories which make each a small power shop in itself.

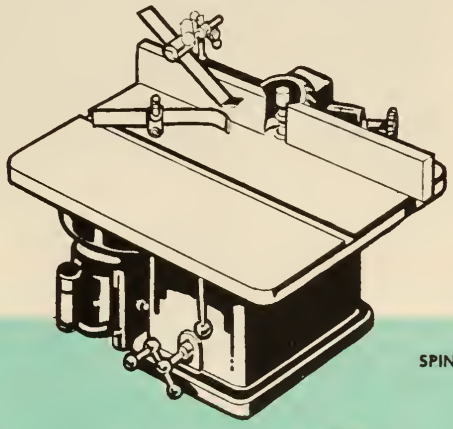
But when you plan shop equipment, consider first the range of usefulness of each tool when measured by your individual needs. Think also about how the addition of other power tools can enlarge the scope and range of shop work. If you have the craftsman's feeling for fine cabinetwork. either modern or traditional, you may like the stationary power tools best. For example, with the stationary (bench-type) power tools shown on this page you can do every operation on a cabinet which requires cutting stock to dimension, jointing edges of stock true for gluing to wider widths, planing stock to various thicknesses which may be required, cutting grooves and rabbets, running the straight and curved moldings required by the design, and making any turnings the construction may call for. But to assemble



4" OR 6"
JOINTER

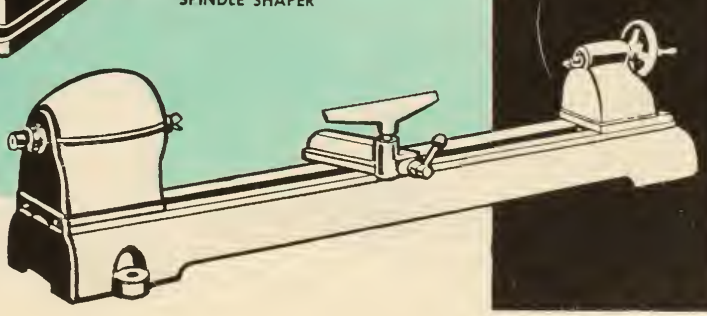


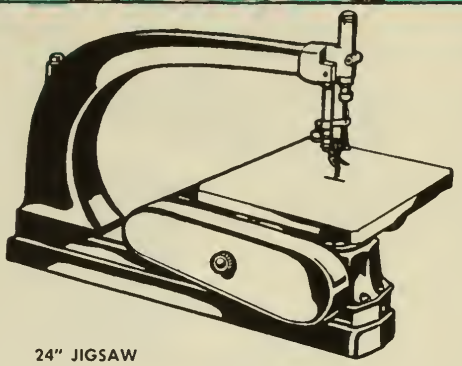
6" PLANER
OR SURFACER



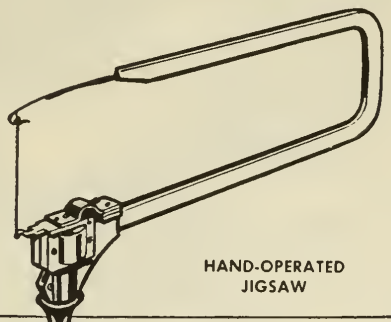
SPINDLE SHAPER

12" WOOD-
TURNING
LATHE

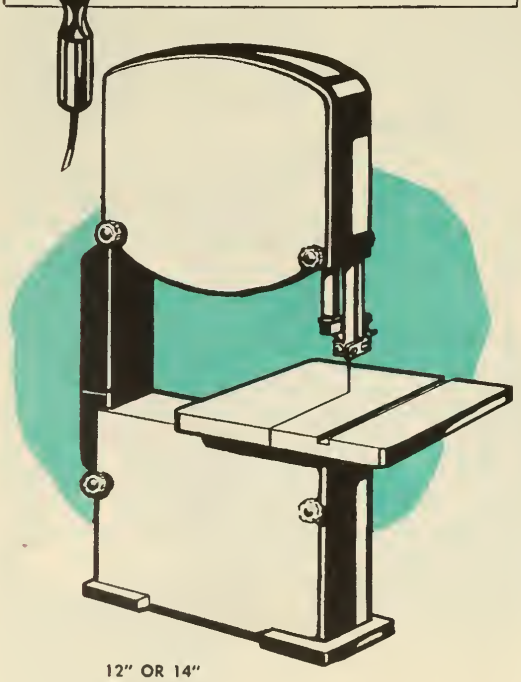




24" JIGSAW



HAND-OPERATED JIGSAW

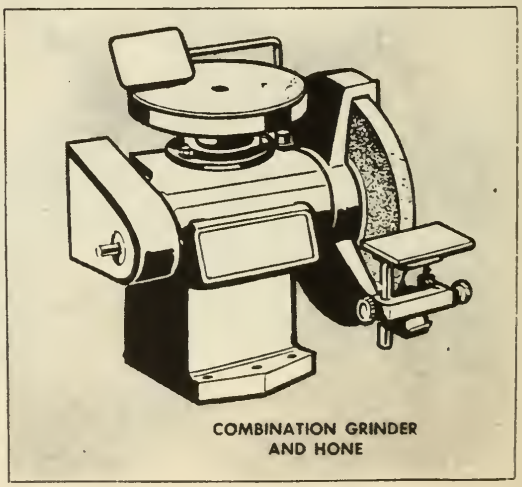


12" OR 14" BANDSAW

and finish the project you still will need the portable drill, the sanders and also the jigsaw if any curved cuts are required by the design. You also will need chisels and a wooden mallet or hammer to finish the mortises square. Or, you can carry out all these final operations with the supplementary hand tools such as the brace and bits, wood chisels, hand-sanding pads and a coping saw for the curved cuts.

Now to go a step farther toward a complete machine-made project. Add the jigsaw, the bandsaw and the drill press shown on these pages and you have the necessary stationary equipment. The jigsaw and bandsaw will enable you to handle the curved cuts. The bandsaw will make any curved cut starting from the edge of the stock. The jigsaw will make curved cuts starting from the edge and also will make any curved cut which does not permit running in from the edge. The drill press with accessory mortising equipment will handle mortises up to ½ in. wide. Matching tenons are cut on the circular saw.

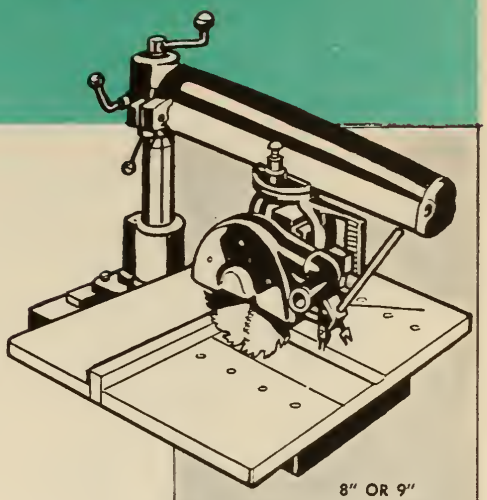
Now, before going farther there are several points to be noted: The work must be carried to the stationary power unit, never the unit to the work. Also, portable power tools often fit in well with stationary power tools and in some cases can supplant them. For example, suppose you already have all the portable power tools pictured on page 1830. The two sanders you'll always have



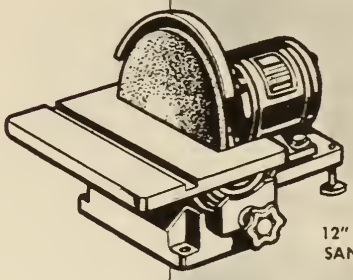
COMBINATION GRINDER AND HONE

use for; the same is true of the portable drill. The portable jigsaw, as an example, can substitute for both the 24-in. jigsaw and the bandsaw. Although somewhat slower, it will make any common curved cut that can be made with either of these machines on stock up to 2 in. or so in thickness. Of course, the portable unit will not work in as short a radius, due to its saber-type blade, as the conventional jigsaw or bandsaw and the cut will not be quite as smooth. Any portable power tool designed to be operated freehand cannot be expected to equal the fine accuracy of the conventional stationary units where squareness of cut or size are factors. When used with floor or bench stands which are available as accessories, the portable electric drill, circular saw and jigsaw approach the conventional stationary units in accuracy of cut on such common operations as crosscutting, ripping, mitering, drilling and jigsawing. Such portable tools as the sanders do not classify with the others as accuracy of cut is not a factor in their operation Keep these differences in mind when selecting portable and stationary power tools.

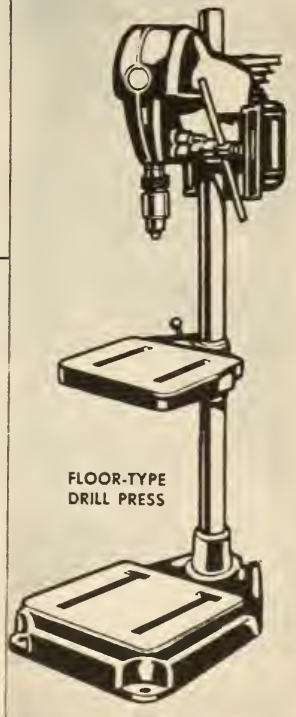
If you're strapped for shop space and there's no practical way to enlarge the working area, then consider a combination power unit such as that illustrated below. Basically it combines a circular saw, drill press and wood lathe in a single stationary floor-type unit. A jointer, bandsaw, jigsaw and paint sprayer are available as accessories for some combination units. Special-purpose tools are the



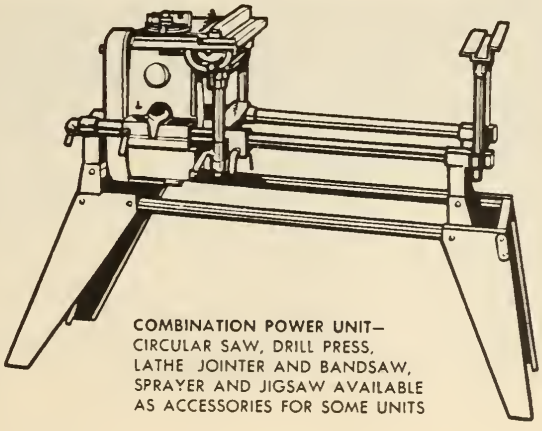
8" OR 9" RADIAL SAW



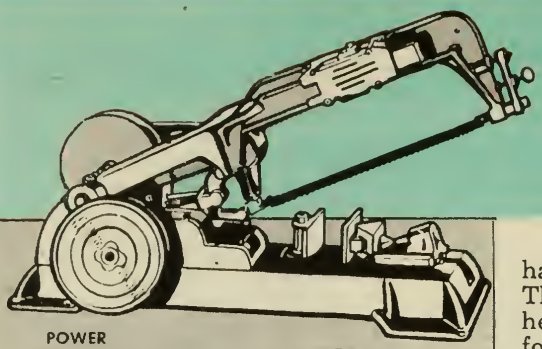
12" DISK SANDER



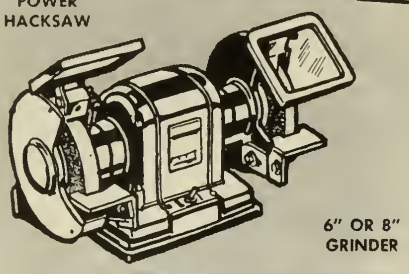
FLOOR-TYPE DRILL PRESS



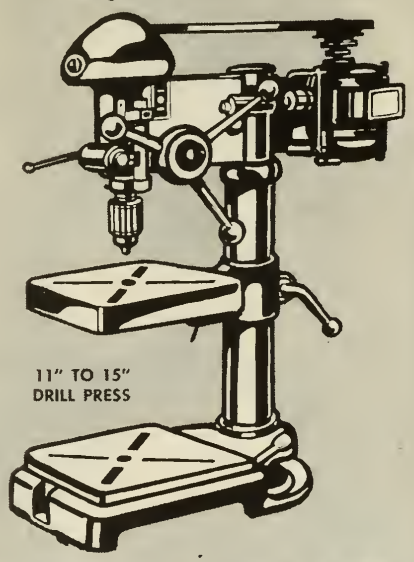
COMBINATION POWER UNIT— CIRCULAR SAW, DRILL PRESS, LATHE JOINTER AND BANDSAW, SPRAYER AND JIGSAW AVAILABLE AS ACCESSORIES FOR SOME UNITS



POWER HACKSAW



6" OR 8" GRINDER

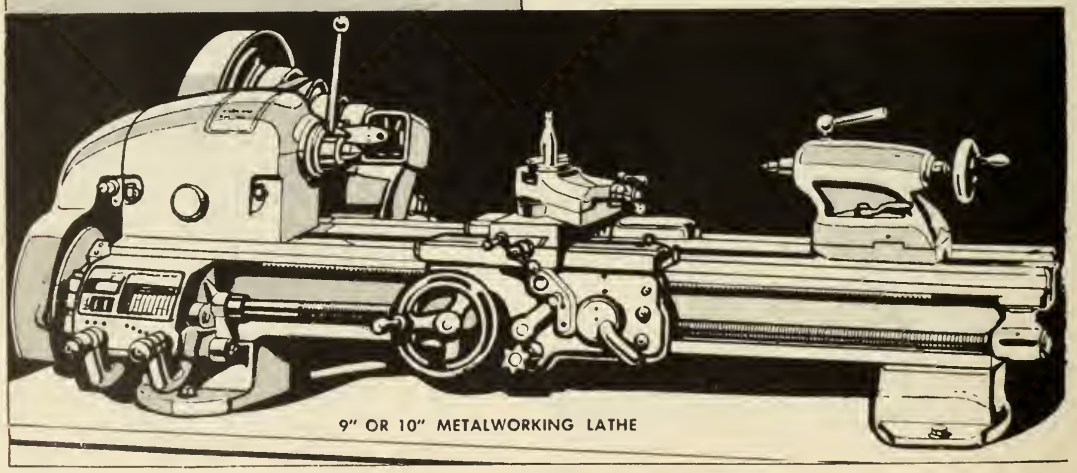


11" TO 15" DRILL PRESS

hand-operated jigsaw and the disk sander. The former is a high-speed jigsaw, hand-held while operated, and especially good for light hobby work on thin stock. You can't beat a disk sander for rounding corners, squaring end grain and truing miters. It's fast and effective for squaring small parts. And, of course, every shop needs a grinder for sharpening tools. There are two types to choose from, the all-purpose type shown at the left and the grinder-hone on page 1832.

Many craftsmen, faced with a choice of the table saw or radial saw, for space or budget reasons, would settle for the radial saw. In considering the two machines, the choice is not so much a matter of accuracy or preference; it is more a matter of adaptability of one or the other to the purpose.

A metalworking lathe with accessories available is almost a metalworking shop in itself. The power hacksaw is a timesaving tool if you have much cut-off work on metal rounds, squares and angles. Otherwise a hand hacksaw will serve. The grinder is a must in the metal shop; also, it would be difficult to get along without the drill press, either the bench type shown at the left, or the floor type shown on a preceding page. The drill press will, of course, handle both wood and metalworking jobs. The metal lathe can double as a wood lathe with the use of wood-turning centers and tool rest, but is not as effective as the standard wood lathe. ★ ★ ★



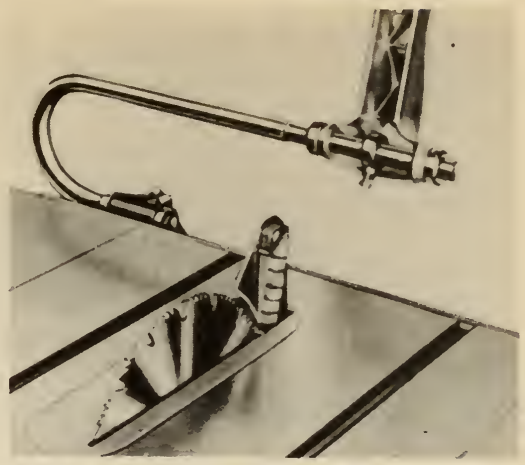
9" OR 10" METALWORKING LATHE

HOW TO USE POWER TOOLS SAFELY

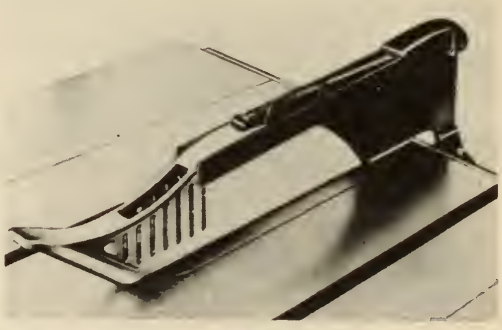
IF YOU ARE ONE of the ever increasing number of "do it yourselfers" who are walking out of hardware and lumber stores the proud owners of brand-new power tools, you are in for a lot of fun and relaxation. But don't let carelessness turn these happy hours into painful ones—do it yourself, but do it safely!

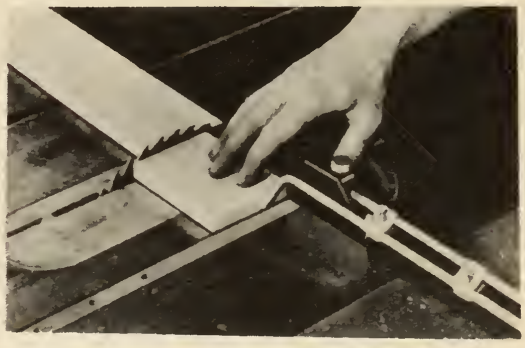
Manufacturers have made their tools as safe to operate as is practical. The truth is that many injuries result from a lack of know-how as much as from plain carelessness, whether the homeowner is sawing pickets for a fence, cleaning paintbrushes or performing some other common do-it-yourself task.

Power tools have made workshop and home repair jobs so simple and quick to do that many become careless in observing ordinary precautions. This is especially true in the case of a circular saw. While most home-workshop machines are provided with protective guards designed to cover the blade completely and include devices to prevent kickback and binding, even the best guards are inadequate for all-around use and become a hindrance. Consequently they are removed and the saw is used with the blade exposed. Best assurance against getting cut when ripping



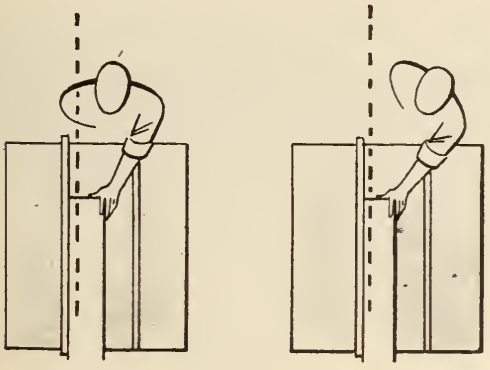
Above, typical swing-back guard, incorporating splitter and antikickback features, gives operator mast protection. Below, splitter and guard is one piece





Above and below, right and wrong way of using stop rod. Wrong way invites pinching and harmful kickback

Kickback, while a saw hazard, need not be feared by the operator. It generally happens when saw fence is out of alignment with blade, which causes the work to pinch and bind at completion of cut and send it flying with force. Even with saw mechanically perfect, adopt safe practice of standing to one side

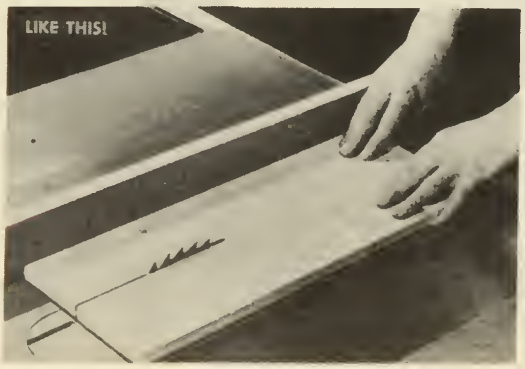


Keep all your fingers by making a notched pusher stick and use it when ripping narrow pieces. Make it a must project when you get your new saw

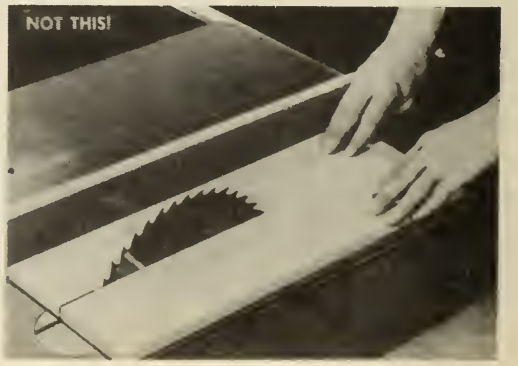
Let's face it! Put a million or more power tools in the hands of a million week-end carpenters and you're going to have accidents due to plain *carelessness*. However, many painful injuries resulting from incorrect usage of power tools can be avoided

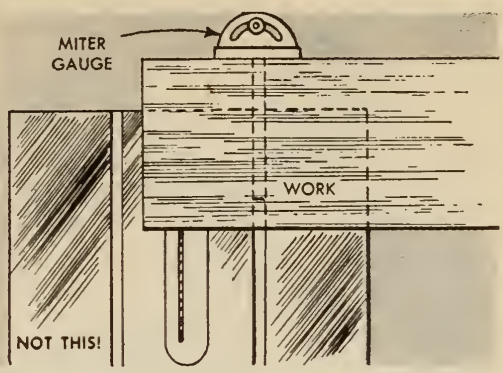
Note: Saw photos show blade unguarded only for sake of clarity. Whenever practicable, guard should be used

When less blade is exposed there's less chance of serious injury. Keep the projection ¼ to ½ in.

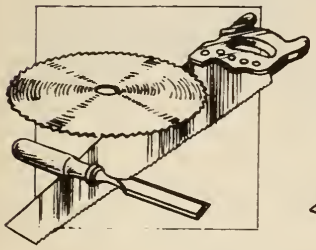


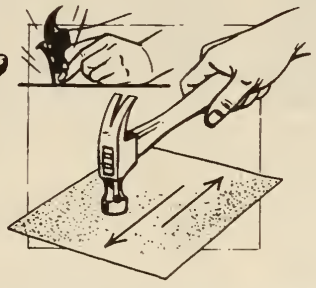
With blade exposed this much, chance of serious cut is greater. Without guard, lower position is safer





Here's a safer way to crosscut a wide board compared to usual way at right. Reverse miter gauge in slot, push work against it



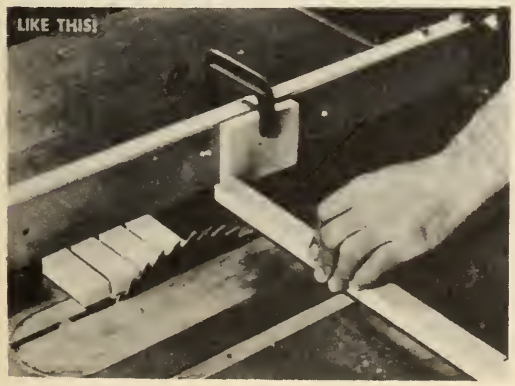


Keep cutting tools sharp—dull tools are a hazard. Smashed thumb is less likely if hammer face is polished with sandpaper

Below and at right, don't use fence as stop without first providing clearance block. Otherwise, work will jam and be thrown

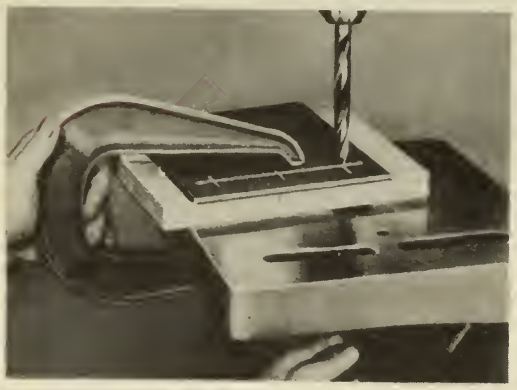
narrow work less than 2 in. wide is to make a push stick and keep it handy. It will keep your hand away from the blade. Another safe practice is to keep the saw blade ¼ to ½ in. above the surface of the work. While it may require slightly more feeding pressure on some types of work, less blade is exposed and thus less chance of a serious injury should you have a mishap.

Kickback, which occurs when the work binds between the fence and the blade and is thrown with considerable force, is another saw hazard that can be charged to lack of know-how. This can happen during both rip and crosscut operations. Antikickback fingers on a splitter-type guard make ripping of narrow pieces a safe operation, although if the operator checks to see that the fence is in exact alignment with the blade, the chance of kickback is remote. In crosscutting where duplicate pieces are being mass-cut, there's a right and wrong way, the latter resulting in binding and kickback. For example, when using a stop rod on the miter gauge, always place it to the left of the blade. Placing it to the right of the blade will cause

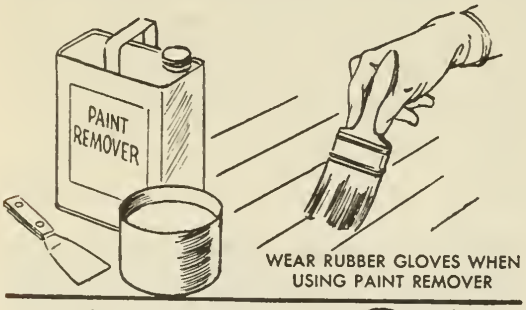


If your bench grinder is without eyeshields, protect your eyes from flying abrasive particles by always wearing goggles

Rockwell Mfg. Co. photos



A most painful cut can be inflicted when drilling sheet metal. Always clamp the work when it is too small to hold so it can't spin when bit breaks through



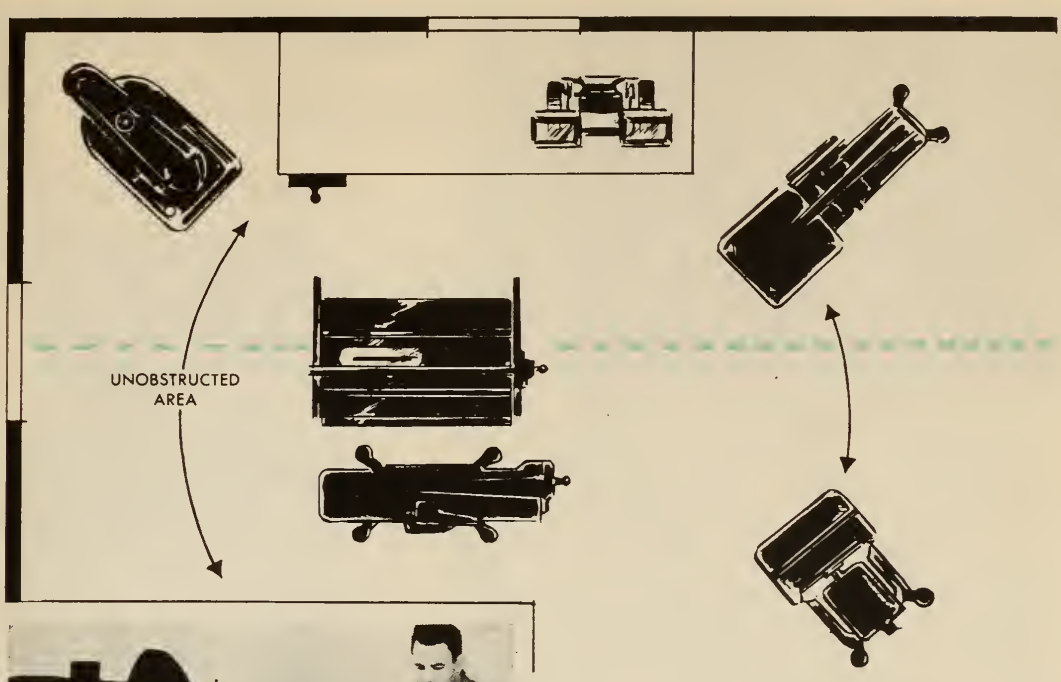
WEAR RUBBER GLOVES WHEN USING PAINT REMOVER

Carelessness in leaving a chuck key in a drill press can cause a bad bruise when the machine is started

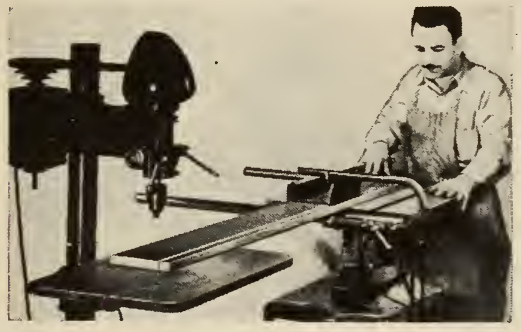
the severed piece to bind, get caught in the blade and fly. Of course, there is a more obvious reason why this shouldn't be done —the blade will strike the stop rod. Where the saw fence is used as a stop in cutting duplicate pieces to length, first clamp a clearance block to the fence as shown on preceding page. Otherwise, the work may bind between blade and fence and be thrown violently. When crosscutting a wide board on a small saw table it is safer to reverse the normal position of the miter gauge in the table slot and push the board against it as pictured at the top of preceding page. Struggling to hold a long board that is being ripped is another way of inviting trouble that could result in an accident. Always provide beforehand some means of support for the outboard end of the work. A floor-model drill press will serve as a fine support since its table can be raised or lowered to equal the height of the saw table.

Dress the part when you work in your shop. Avoid dangling shirt sleeves—either roll them all the way up or keep them buttoned. Certainly avoid wearing a tie which could become caught in a lathe or drill press. Perhaps the safest apparel is a snug-fitting sweat shirt. Arrangement of tools in your shop has a lot to do with safety. Many mishaps have been caused by long work striking other machines while being cut.

If you own a portable electric drill or handsaw, it is best to make use of the ground-connection wire that is a part of the plug. This third wire is for your protection in the event a short should develop in the switch or the tool itself. It is designed to replace the center screw that holds the



There's safety to be had in proper shop layout. Try to arrange tools to give unobstructed area around saw

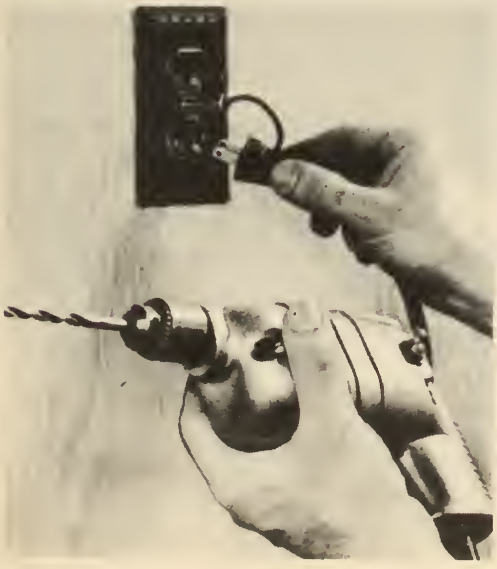


Drill press provides extra support when sawing long boards. Trying to hold such long work invites trouble

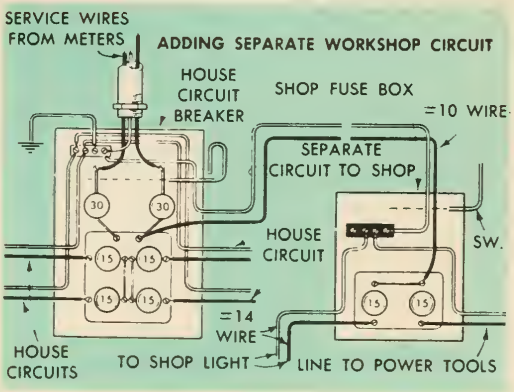
receptacle cover. As a precaution against overloading existing circuits, you should take the time to run a separate circuit to your workshop. The diagram below shows how No. 10-ga. wires are run from the main fuse box, or circuit breaker, to a separate fuse box in the shop from which No. 14-ga. wires are run to individual plug-in receptacles.

In working with other shop tools, such as a drill press, be sure to remove the chuck key before turning on the machine, and in drilling thin work like sheet metal make it a practice to clamp the work to the table. Many a bad cut has been inflicted by the work spinning as the bit breaks

Use ground wire on your portable tools. Ground-wire receptacle is grounded to metal conduit or metal box



Separate circuit for workshop safeguards house wiring from overloading. Typical wiring is shown below



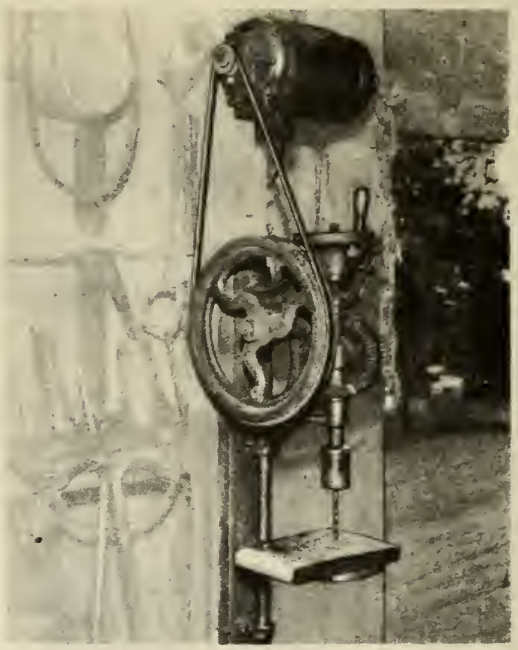
Make a hold-down pusher block and use it whenever you plane thin stock on jointer. It will save your hand

through. If your bench grinder is not fitted with eyeshields, have a pair of goggles handy to protect your eyes from flying particles. In planing thin stock on a jointer, make a hold-down pusher block, as shown, to safeguard your hand and give better support. Also, while it is perfectly safe to joint edge grain in the case of wide plywood panels, never attempt to plane edge grain of work narrower than 8 in.

Other precautions that contribute to safe do-it-yourself include keeping flammable oil or paint-soaked rags in metal containers. Special care must be used in handling quick-drying lacquers. Do spray-painting outdoors whenever possible. Cleaning of paintbrushes in solvents should likewise be done outdoors. Always wear rubber gloves when handling paint removers, thinners and other toxic finishing materials that may irritate the skin. ★ ★ ★

Never plane the end grain of work that is less than 8 in. wide. Narrower stock will catch in jointer knives

Electrified Post Drill Used as Power Tool With Minor Alterations



With minor modifications many hand-powered machines, such as the post drill in the photograph, can be converted to use as a power tool. In the case of the drill, an electric motor was bolted to the wall above it and a V-belt of the proper length passed around the flywheel of the drill and a pulley on the motor. The hand-powered tools, of course, are not built to run at speeds as high as regular power tools.

Foot Switch Added to Power Tool Affords Convenient Control

A foot switch of the type used with photo enlargers can be adapted easily for use with a jigsaw, bandsaw or other power tool. The switch, which is wired in series with the power tool, conveniently permits instant starting and stopping without need for taking the hands from the work.

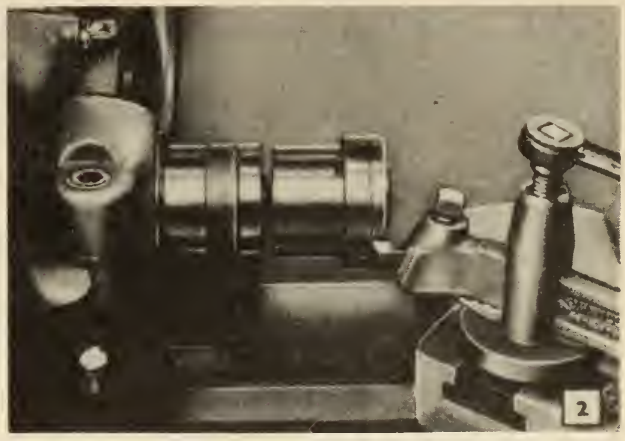
¶To prevent misplacing the instruction sheets and parts lists that come with power tools, drop them into a glass jar having a screw-type lid. The jar is stored with attachments that go with the machine.

CLUTCH CONTROLS POWER TOOLS

A clutch permits smooth, gradual starts and stops, achieves a degree of spindle control not otherwise possible on small machines

By Walter E. Burton

1

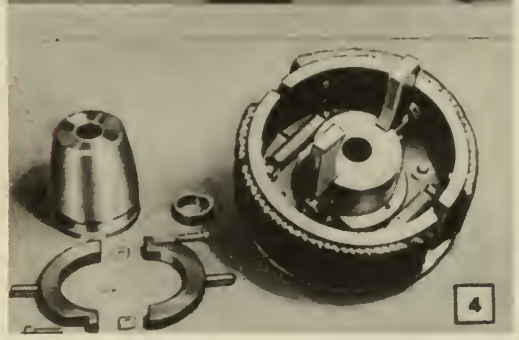

2

THIS CLUTCH is especially useful for controlling a small lathe or milling machine when you're doing close work and it is necessary to start and stop the machine frequently. As detailed, it is assembled with pulleys of the same diameter for use with a small bench lathe without changing the original motor-to-jackshaft pulley ratio. Pulleys of varying diameters can be used to adapt the unit to other uses.

The braking mechanism consists of a drum controlled by internal-expanding shoes actuated by a hand lever. Parts of the clutch are pictured in Figs. 3, 4 and 5 and an assembly view and sectional view are shown in Fig. 6. The clutch is pictured being assembled in Fig. 1, the hub being machined in Fig. 2 and the clutch completely assembled and mounted to drive a small lathe is pictured in Fig. 7. The parts are assembled on a 10½-in. length of ½-in. steel shafting, the shaft being mounted on ½-in. ball-bearing pillow blocks. The pulley A, Fig. 6, on which the clutch mechanism is mounted, is bronze-bushed as it must turn freely on the shaft when the clutch is disengaged.

The clutch mechanism is attached to pulley A, Fig. 6, and consists of the back plate B, the hub flange C, the split ring D, the halves of which carry the shoes, the clutch hub, arms and sliding cone. These parts in their relative positions are shown in the sectional view, Fig. 6. The drum can be made from extra-heavy pipe or from steel tubing having a $\frac{7}{32}$-in. wall. The backplate B, Fig. 6, is cut from $\frac{3}{16}$-in. steel plate and is drilled near the edge for 6-32 screws, the holes being equally spaced. Using the plate as a template, drill and tap holes for 6-32 screws in one edge of the drum. On approximately the same spacing, holes are drilled for the ⅛-in. rivets which hold the plate to the web of the pulley, A. A center hole is drilled and reamed to ½ in. to fit the shaft. The brake shoes, or clutch shoes, are semicircular segments cut from steel tubing having a $\frac{3}{16}$-in. wall and an outside diameter of 3½ in. The shoes are faced with regular brake lining riveted in place. One edge of each shoe is drilled and tapped for three 6-32 screws so that the split rings, or segments, can be attached to the shoes in the same manner as the drum is attached to the backplate. Note that the assembly

3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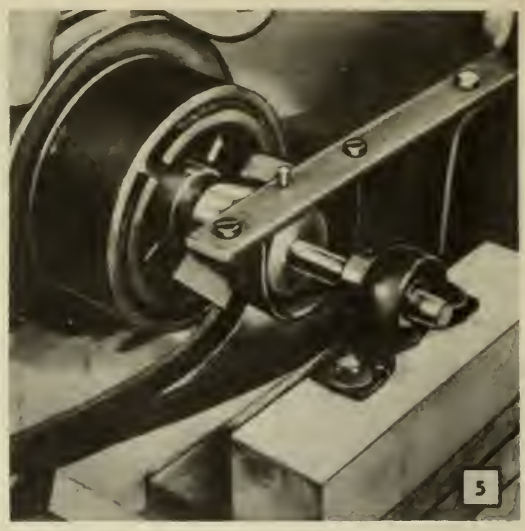
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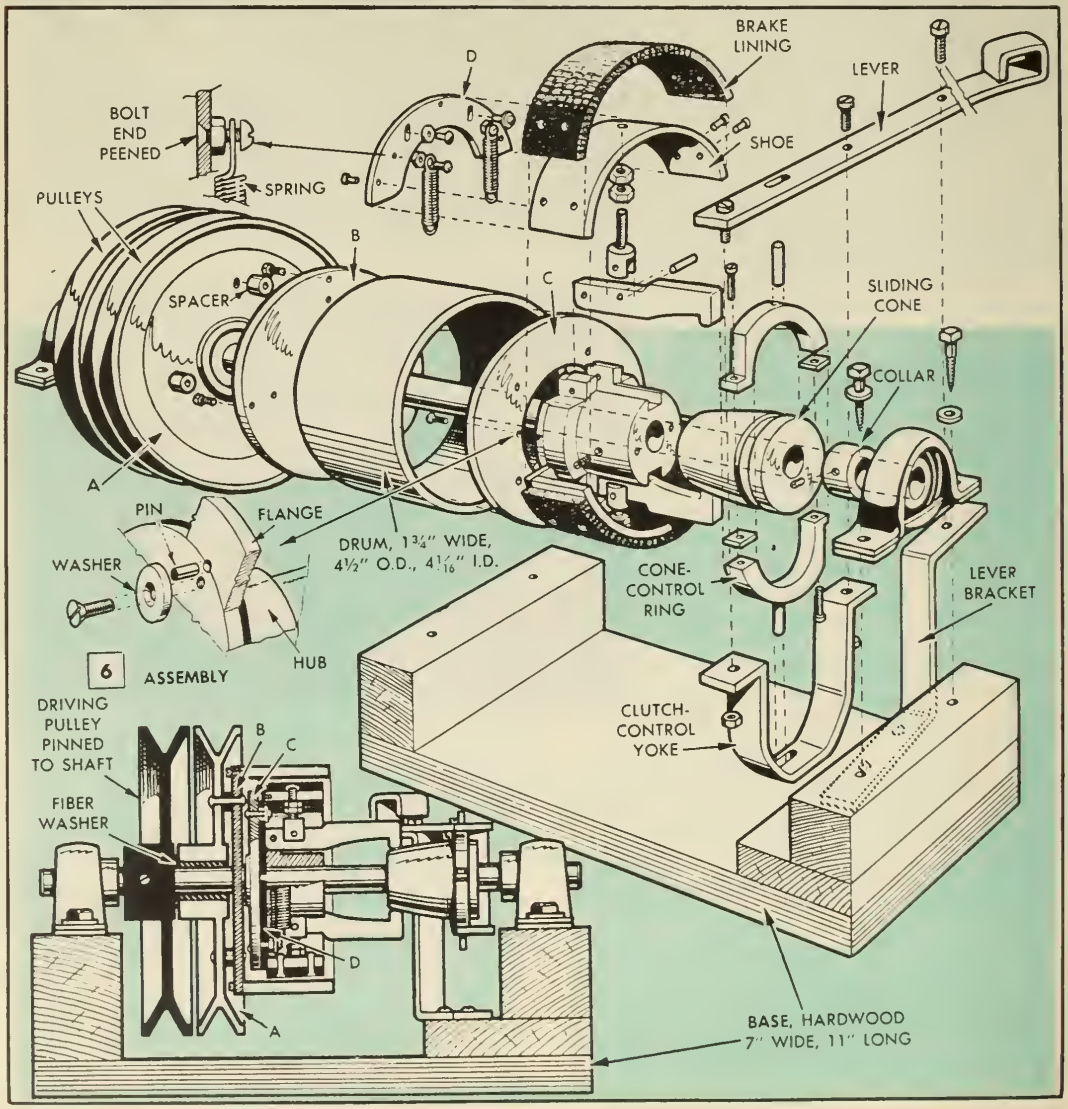
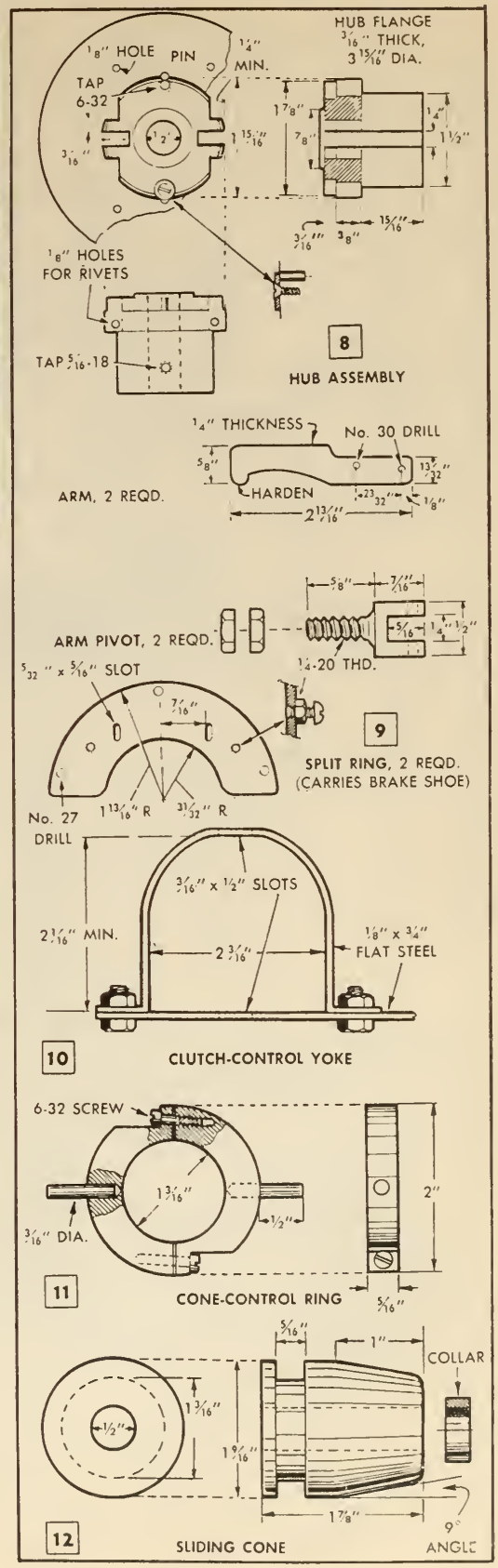
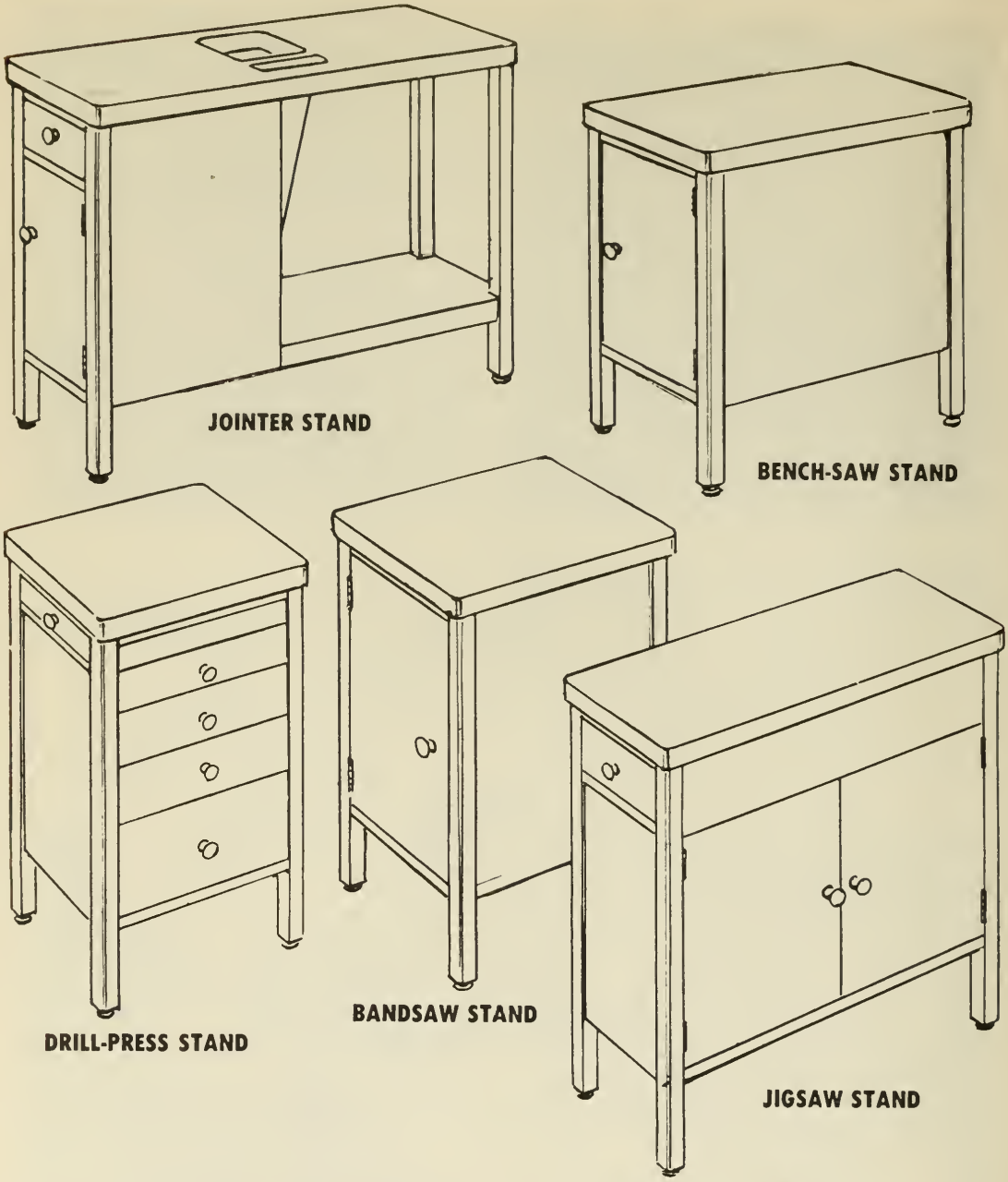

BRAKE LINING
D
LEVER
BOLT END PEENED
SHOE
SPRING
PULLEYS
B
C
SLIDING CONE
SPACER
COLLAR
A
PIN
FLANGE
DRUM, 1¾" WIDE, 4½" O.D., 4 1/16" I.D.
WASHER
CONE-CONTROL RING
LEVER BRACKET
HUB
6 ASSEMBLY
DRIVING PULLEY PINNED TO SHAFT
B
C
CLUTCH-CONTROL YOKE
FIBER WASHER
D
A
BASE, HARDWOOD 7" WIDE, 11" LONG

(shoe and split ring, D) is riveted to the hub flange, the rivet ends being peened over on washers to permit each shoe free movement in and out as the clutch is engaged and released.

The hub, Figs. 6 and 8, can be made by turning to outside dimensions and then filing in the grooves, but it is best to have it milled to final shape. Note that the hub is shouldered at the big end to take the flange. The latter is pinned (with two round pins) to the hub. The pins are held in place with screws and retaining washers as in the detail, Fig. 6. Main parts of the clutch mechanism are detailed in Figs. 8 to 12 inclusive. The base, Fig. 6, is dimensioned as 7 x 11 in., but its general construction and the height of the riser blocks will depend to some extent on the application.

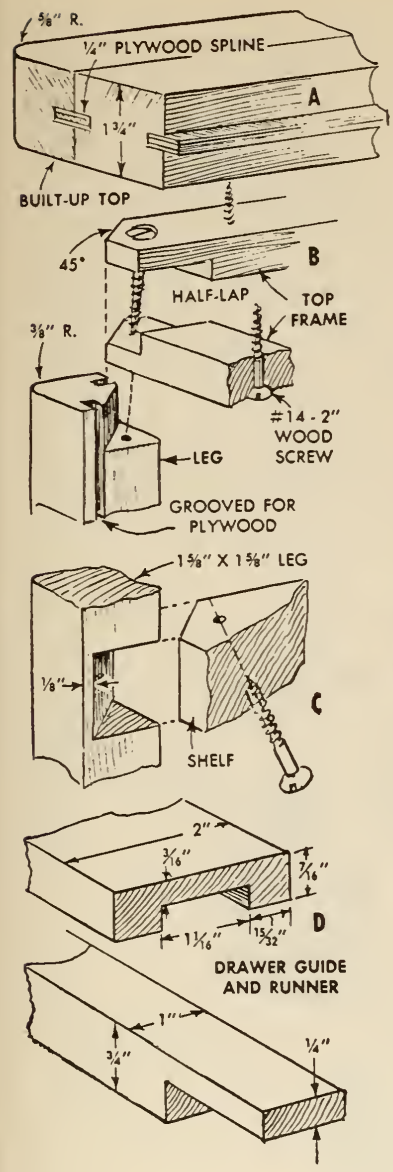
In an assembly of this type some hand fitting will be necessary. As an example, note in Figs. 6 and 9 that the arm pivots are fitted with locknuts for adjustment. This adjustment usually can be determined with fair accuracy when the brake-shoe unit has been assembled to the stage pictured in Fig. 4. The control ring, Figs. 6 and 11, should be hand-fitted as it is necessary that it be shimmed to just the right amount of clearance. If the ring is fitted loosely, it may tend to bind. Although not detailed, it's a good idea to provide small oilholes in the hub of the pulley A, the clutch hub and also in the control ring. A drop or two of oil placed in the oilholes occasionally will cause the clutch to operate somewhat more smoothly and, equally important, will help to reduce wear on the parts when the work requires frequent starting and stopping with comparatively long idling periods. As pictured, the clutch operated smoothly at speeds up to 500 r.p.m. Higher speeds are not advisable.

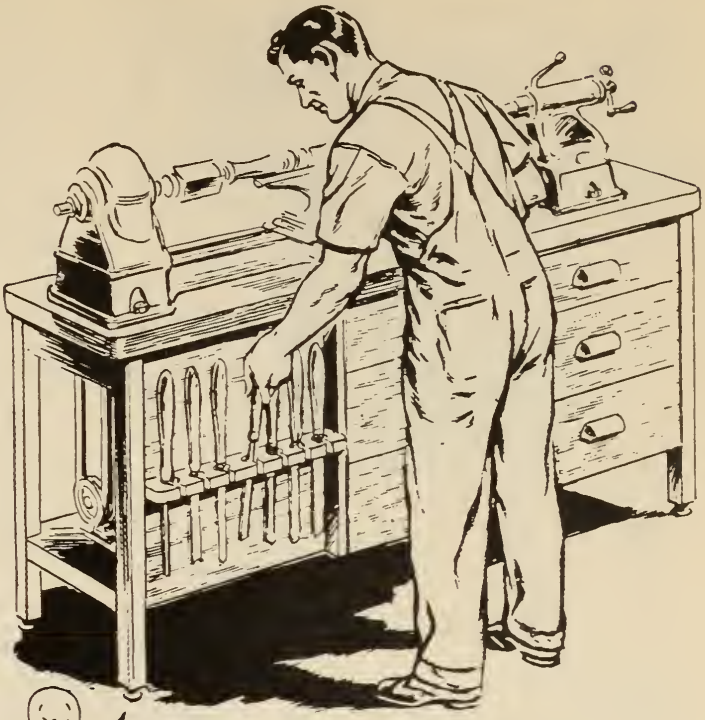


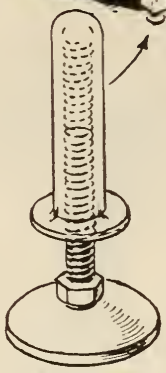


POWER-TOOL STANDS

THE FIRST REQUIREMENT for satisfactory operation of a bench-type power tool is a rigid floor stand. These five stands have been especially designed by John Bergen for the most frequently used power tools in the home workshop and provide space for chip disposal and storage of accessories. The legs of each stand are adjustable for height, permitting the units to be leveled on an uneven floor. Basically, the construction of all stands is the same, the tops, legs and rails being joined as in details A, B and C on the facing page. The drawers slide on the center-runner-and-guide assembly shown in detail D. Dimensions vary with the type of stand and the machine for which it is designed and, in some instances, it may be advisable to depart from those given in order to bring the machine tables to a comfortable height for the individual user. When building the bench-saw and jointer stands, which require openings for discharge of chips and the drive belt, you can save considerable







MATERIAL LIST

Clear Lumber

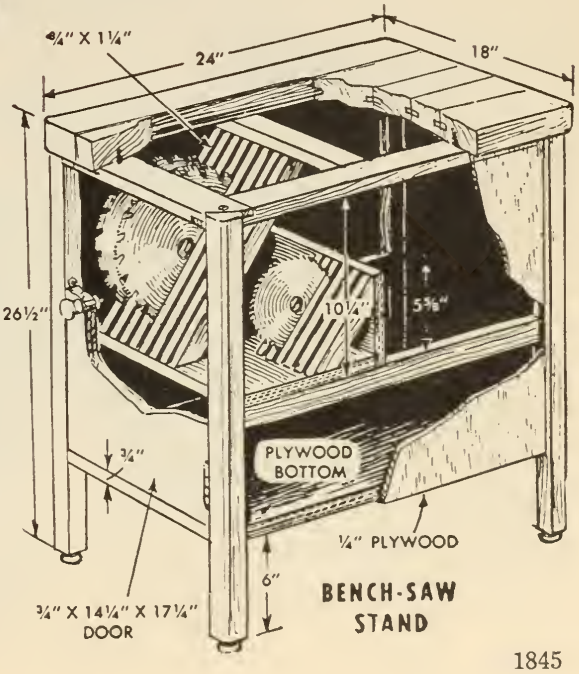
1 pc.—1 3/4" x 18" x 24"—Top (built-up)
4 pcs.—1 5/8" x 1 5/8" x 25 3/4"—Post
2 pcs.—3/4" x 1 3/4" x 23"—Top side frame
3 pcs.—3/4" x 13 3/4" x 16 1/2"—Top front center & back frames
2 pcs.—3/4" x 1 1/4" x 20 1/4"—Side shelf cleats
9 pcs.—3/4" x 1 1/4" x 15 7/8"—Saw-rack rails
6 pcs.—3/4" x 1 1/4" x 83/8"—Saw-rack rails
1 pc.—3/4" x 5 5/8" x 16 1/2"—Shelf back

Plywood

1 pc.—3/4" x 14 1/4" x 17 1/4"—Door
1 pc.—3/4" x 10" x 16 1/2"—Shelf
1 pc.—3/4" x 16 1/2" x 23"—Shelf

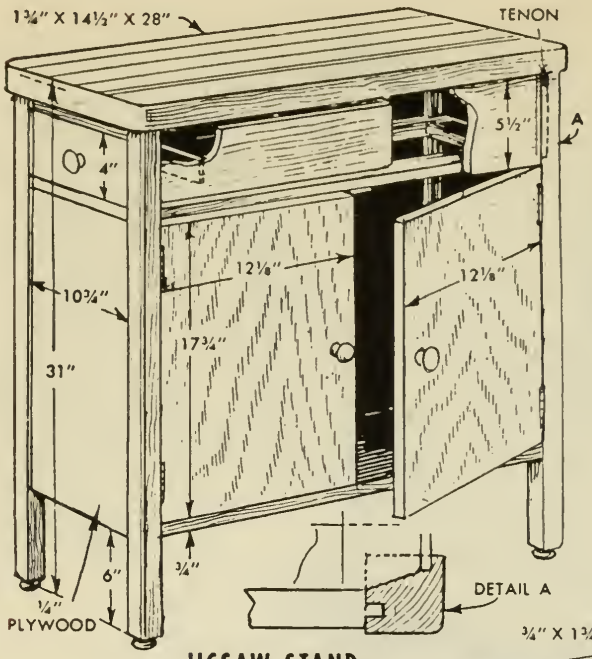
Hardboard

1 pc.—1/4" x 15" x 18"—Back
2 pcs.—1/4" x 18" x 21"—Sides
2—Butt hinges, 1 3/4" x 1 1/4" open
4—Adjustable glides
1—1" dia. knob
1—3/8" bullet catch



stock by first determining the required size of the openings and then cutting the stock accordingly. In making the top for the jointer stand, for example, you can cut a number of pieces 42 in. long and then use filler strips 17 in. long to form the openings for both chips and the drive belt. Note in detail A the built-up construction of the tops. Either soft wood, such as pine, or hardwood, such as maple or birch, can be used for the tops. The motor shelf on the jointer and lathe stands can be made of the same material joined with glue and plywood splines as in detail A. When cutting stock for the motor shelves and tops, cut each piece slightly longer than the finish dimension to allow for trimming the top to the required size. Tops should be sanded smooth

on both sides so that they fit properly on the stands. Drawers in the lathe and drill-press stands are of identical construction; they vary only in overall size and the type of pulls pictured. Note that the lower edge of the drawer front extends a distance equal to the thickness of the rail and that the latter is set in from the corner of the leg a distance equal to the thickness of the drawer front. Made in this way, the drawers close flush. This type of construction makes it possible to use a simple half-lap joint when assembling the rail-and-runner frames as these parts are not exposed in the finished job. It is advisable to use ½ or ⅝-in. plywood for the bottoms of the two full-width drawers if they are to be used for storage of heavy objects. Finish the stands in the natural color of the wood or in colors to match the shop equipment.



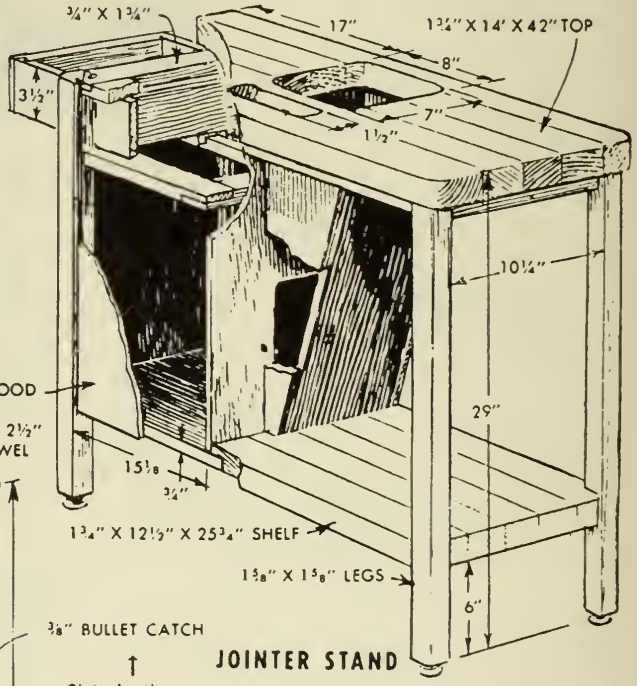
JIGSAW STAND

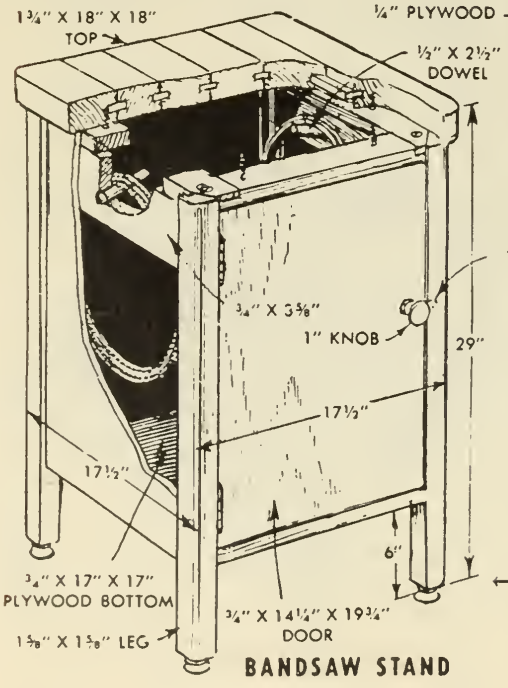
Clear Lumber
1 pc.—1¾" x 14½" x 28"—Top
4 pcs.—¾" x 13¾" x 12¾"—End drawer rails
4 pcs.—¾" x 13¾" x 27"—Side drawer rails
4 pcs.—1⅝" x 1⅝" x 29¼"—Posts
1 pc.—¾" x 5½" x 25"—Side rail
1 pc.—¾" x 3⅞" x 10⅝"—Drawer front
1 pc.—½" x 3-11/16" x 9¾"—Drawer back
2 pcs.—½" x 3-15/16" x 16⅜"—Drawer sides

Hardboard
1 pc.—¼" x 11½" x 9¾"—Drawer partition
1 pc.—¼" x 9¾" x 15½"—Drawer bottom
1 pc.—¼" x 11½" x 18"—End
1 pc.—¼" x 11½" x 23½"—End
1 pc.—¼" x 23¼" x 25"—Side

Plywood
1 pc.—¾" x 13½" x 26½"—Shelf
2 pcs.—¾" x 12⅛" x 17¾"—Doors

Hardwood
1 pc.—¾" x 1" x 26¼"—Drawer guide
1 pc.—7/16" x 2" x 15½"—Drawer slide
2—⅝" dia. bullet catches
3—1" dia. knobs
4—Adjustable glides
4—Butt hinges, 1¾" x 1¼" open





BANDSAW STAND

JOINTER STAND

Clear Lumber
4 pcs.—1⅝" x 1⅝" x 27¼"—Posts
1 pc.—13½" x 12½" x 25¾"—Motor shelf
2 pcs.—¾" x 2½" x 41"—Side rails
5 pcs.—¾" x 13¾" x 12½"—End & center rails
1 pc.—¾" x 31½" x 10¾"—Drawer front
1 pc.—½" x 31-7" x 9¼"—Drawer back
2 pcs.—½" x 9½" x 13¾"—Drawer sides
2 pcs.—¾" x 2½" x 16½"—Side drawer rails

Plywood
1 pc.—¾" x 10¼" x 15½"—Door
1 pc.—¾" x 12½" x 18"—Shelf
1 pc.—¾" x 9" x 19½"—Dust-chute side
1 pc.—¾" x 8⅞" x 21⅞"—Dust-chute end

Hardwood
1 pc.—¾" x 1" x 15½"—Drawer guide
1 pc.—7/16" x 2" x 14½"—Drawer slide

Hardboard
1 pc.—¼" x 9¼" x 14½"—Drawer bottom
1 pc.—¼" x 15½" x 21⅝"—Side
1 pc.—¼" x 21⅛" x 25¼"—Side
1 pc.—¼" x 12½" x 20¼"—End

Clear Lumber
4 pcs.—1⅝" x 1⅝" x 27¼"—Posts
2 pcs.—¾" x 1¾" x 16½"—Front & back top frame
2 pcs.—¾" x 1¾" x 17"—Side top frame
2 pcs.—¾" x 3⅝" x 14¼"—Side cleats

Plywood
1 pc.—¾" x 16½" x 17"—Shelf

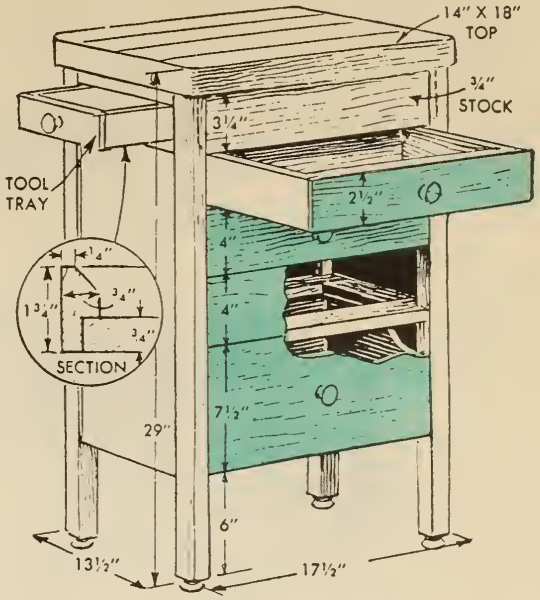
Hardboard
3 pcs.—¼" x 15" x 21¼"—Sides & back

MATERIAL LIST

Clear Lumber
1 pc.—1¾" x 14" x 18"—Top (built-up)
2 pcs.—¾" x 2¾" x 12¼"—Tray side rails
2 pcs.—¾" x 2¼" x 12¼"—Tray side rails
8 pcs.—¾" x 2¼" x 12-3/16"—Side drawer rails
4 pcs.—¾" x 13¼" x 17"—Tray front & back rails
8 pcs.—¾" x 13¼" x 16½"—Front & back drawer rails
1 pc.—¾" x 21½" x 14¼"—Drawer front
2 pcs.—¾" x 4" x 14¼"—Drawer fronts
1 pc.—¾" x 7½" x 14¼"—Drawer front
1 pc.—½" x 11½" x 13¼"—Drawer back
2 pcs.—½" x 3" x 13¼"—Drawer backs
1 pc.—½" x 6½" x 13¼"—Drawer back
2 pcs.—½" x 13¼" x 12⅜"—Drawer sides
4 pcs.—½" x 3¼" x 12⅜"—Drawer sides
2 pcs.—½" x 6¾" x 12⅜"—Drawer sides
2 pcs.—¾" x 15⅜" x 10⅛"—Front & back tray sides
2 pcs.—¾" x 15⅜" x 13½"—Side tray sides
1 pc.—¾" x 3¼" x 15"—Front rail
4 pcs.—15⅜" x 1⅜" x 27¼"—Posts

Hardwood
4 pcs.—¾" x 1" x 12-3/16"—Drawer guides
4 pcs.—7/16" x 2" x 11¼"—Drawer slides
1 pc.—¾" x 1" x 14⅜"—Tray guide

Hardboard
4 pcs.—¼" x 11¼" x 13¼"—Drawer bottoms
1 pc.—¼" x 15" x 21¼"—Back
1 pc.—¼" x 11" x 21¼"—Side
1 pc.—¼" x 11" x 17¼"—Side
4—1" dia. knobs
4—Adjustable glides
1—½" dia. knob with wood screw



DRILL-PRESS STAND

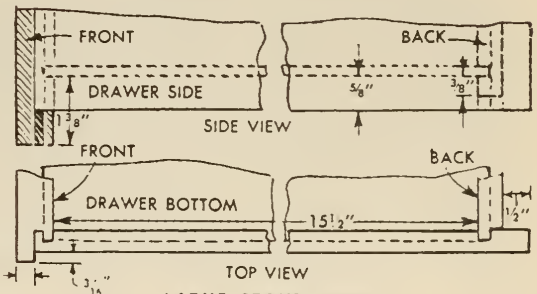
MATERIAL LIST

Clear Lumber
1 pc.—1¾" x 18½" x 60"—Top
1 pc.—1¾" x 15⅝" x 16⅜"—Motor shelf
4 pcs.—1⅝" x 1⅝" x 29¾"—Posts
6 pcs.—¾" x 2½" x 57¼"—Front & back rails
2 pcs.—¾" x 2½" x 45⅞"—Bottom front & back rails
3 pcs.—¾" x 2¾" x 16⅜"—Side rails
2 pcs.—¾" x 13¼" x 16⅜"—Side rails
1 pc.—¾" x 13¼" x 17⅜"—Top side rail
1 pc.—¾" x 2¾" x 17⅜"—Top side rail
1 pc.—¾" x 3¼" x 16⅜"—Bottom side rail
1 pc.—¾" x 3⅝" x 15½"—End rail
1 pc.—¾" x 35⅛" x 15¼"—Back rail
1 pc.—¾" x 11¼" x 14¾"—End top cleat
1 pc.—¾" x 13¼" x 14⅛"—Back top cleat
1 pc.—¾" x 11½" x 14⅛"—Front top cleat
1 pc.—¾" x 7⅛" x 23"—Front facing strip
2 pcs.—¾" x 6" x 20-11/16"—Drawer fronts
2 pcs.—¾" x 8½" x 41⅜"—Drawer fronts
2 pcs.—½" x 5" x 19-11/16"—Drawer backs
2 pcs.—½" x 7½" x 40⅜"—Drawer backs
4 pcs.—½" x 5¼" x 16⅞"—Drawer sides
4 pcs.—½" x 7¾" x 16⅞"—Drawer sides
1 pc.—¾" x 23¼" x 16⅝"—Center rail
1 pc.—¾" x 13¼" x 14⅛"—Tool rack

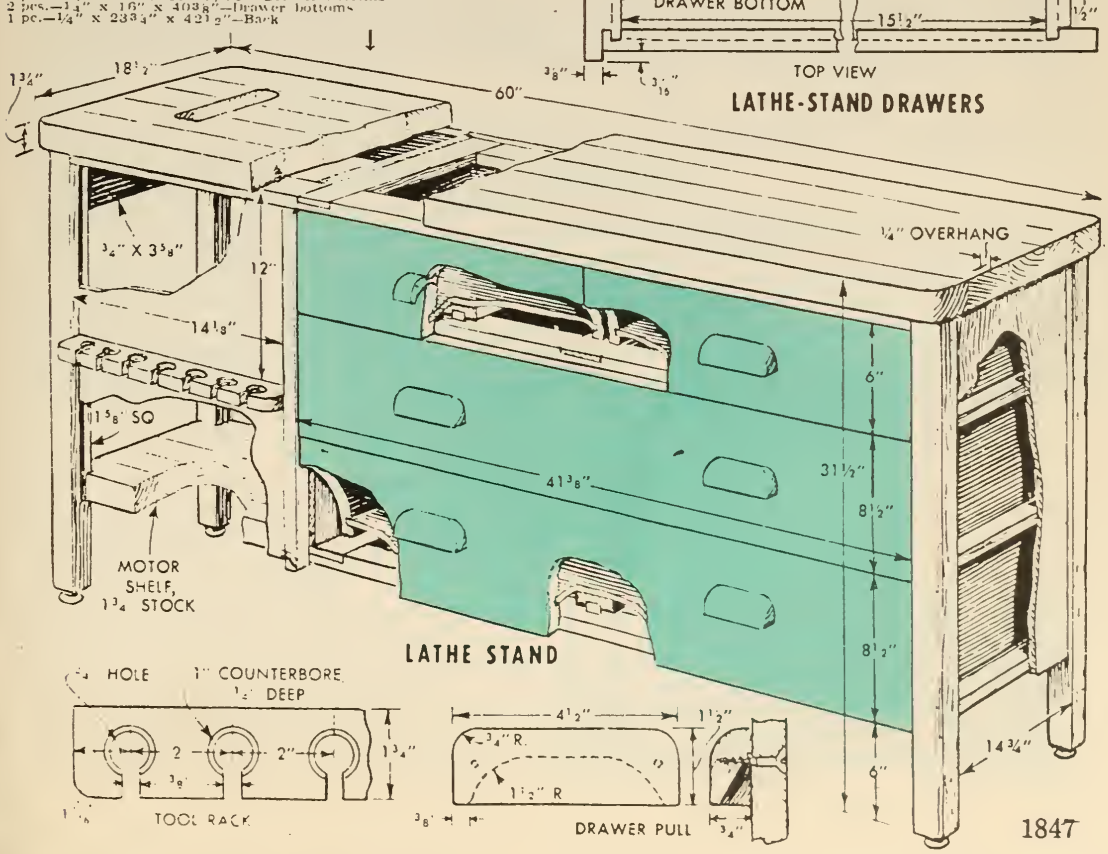
Hardwood
4 pcs.—¾" x 11¼" x 16⅝"—Drawer guides
4 pcs.—½" x 23¾" x 15½"—Drawer slides
6 pcs.—¾" x 11½" x 41½"—Pulls

Plywood
1 pc.—¾" x 16⅜" x 23"—Side
1 pc.—¼" x 14⅜" x 23¼"—Tool-rack panel

Hardboard
1 pc.—¼" x 15½" x 23½"—Side
2 pcs.—¼" x 16" x 19-11/16"—Drawer bottoms
2 pcs.—¼" x 16" x 40⅜"—Drawer bottoms
1 pc.—¼" x 23¾" x 42½"—Back



LATHE-STAND DRAWERS

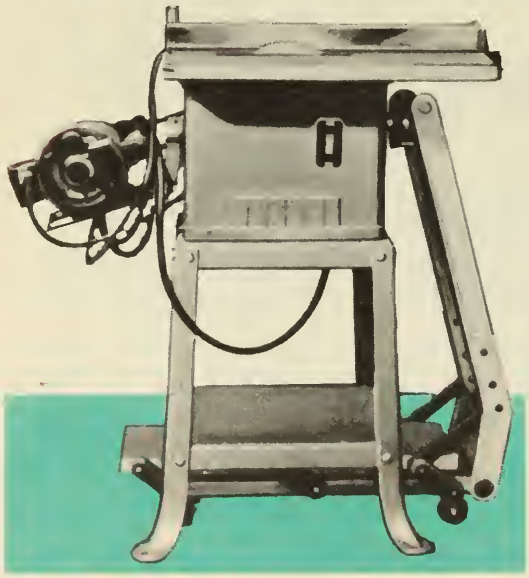


LATHE STAND

Handy Tool Dolly

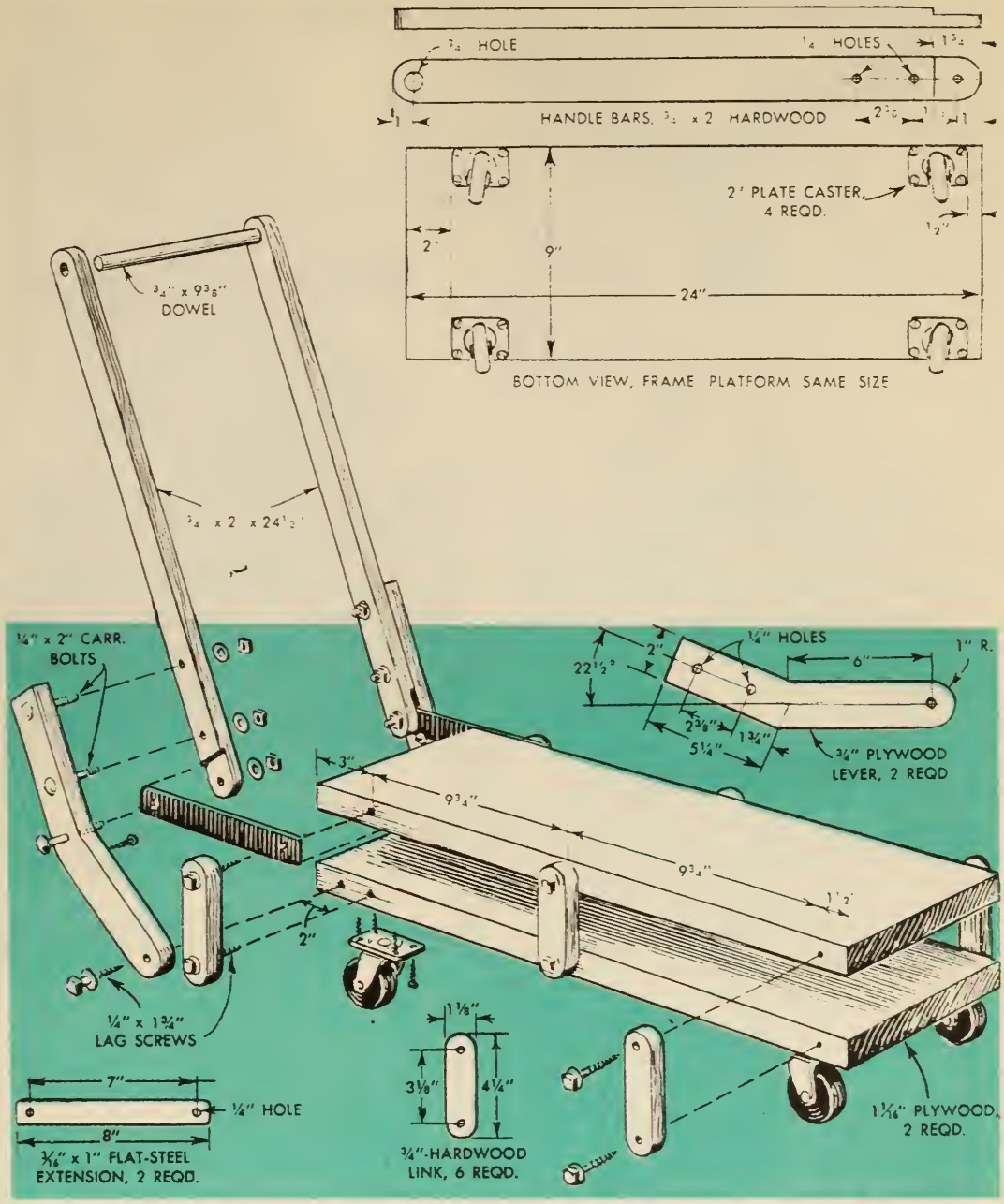
By Howard R. Clark

Above, just lower the handle of the dolly to raise the machine clear of the floor. Below, raising the handle lowers the platform to clear machine table

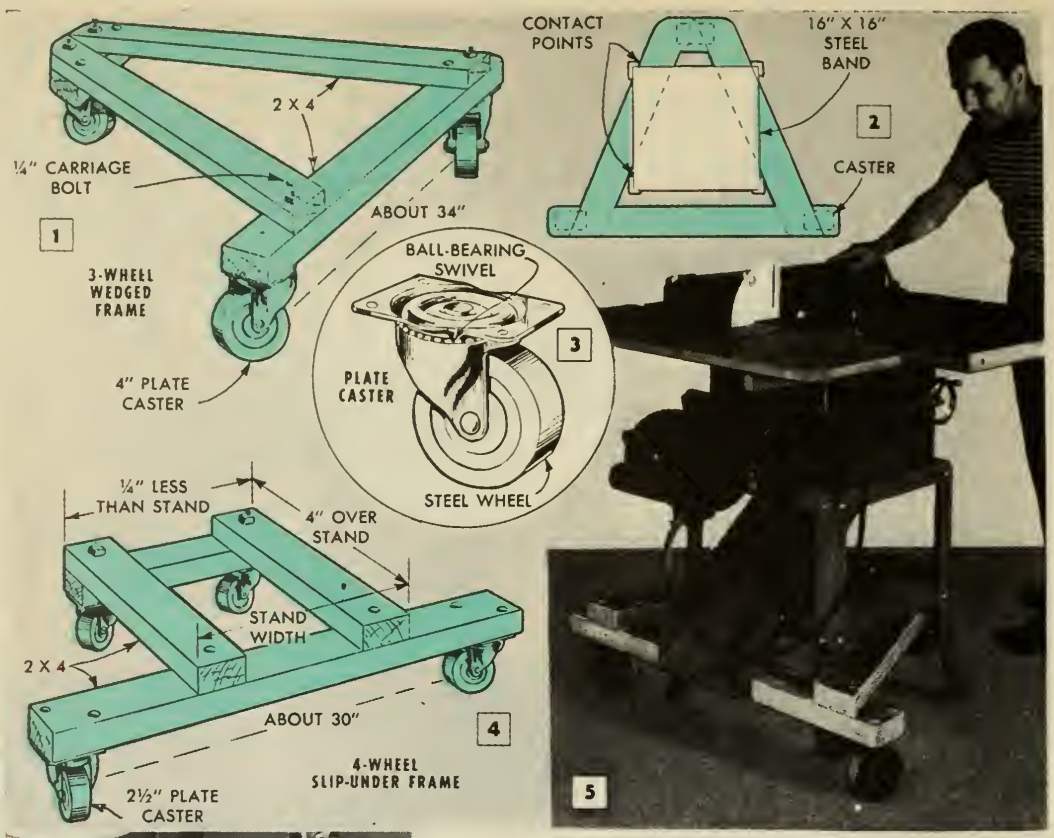


POWER TOOLS ON STANDS are heavy, difficult to move about in the shop singlehanded unless you have this dolly. Then it's easy. Just roll the dolly under the stand as pictured at the left , lower the handle as shown above and away you go. Swiveling casters on the dolly make it easy to spot the machine just where you want it for ripping a long board, or moving it out of the central floor area of the shop for some other operation, such as laying out the lines full size for a boat hull.

The dolly can be made to suit almost any type of open tool stand and it also can be useful when moving other heavy units, such as workbenches. Before you cut stock from the dimensions on the following page. check your tool stands for height to the shelf or rails. You may have to shorten or lengthen the hardwood links or use larger or smaller casters. As dimensioned, the dolly is suited to the type of stand pictured. also other types having a lower shelf or rails at approximately the same height from the floor. The handle bars of the original dolly are minimum length. Where

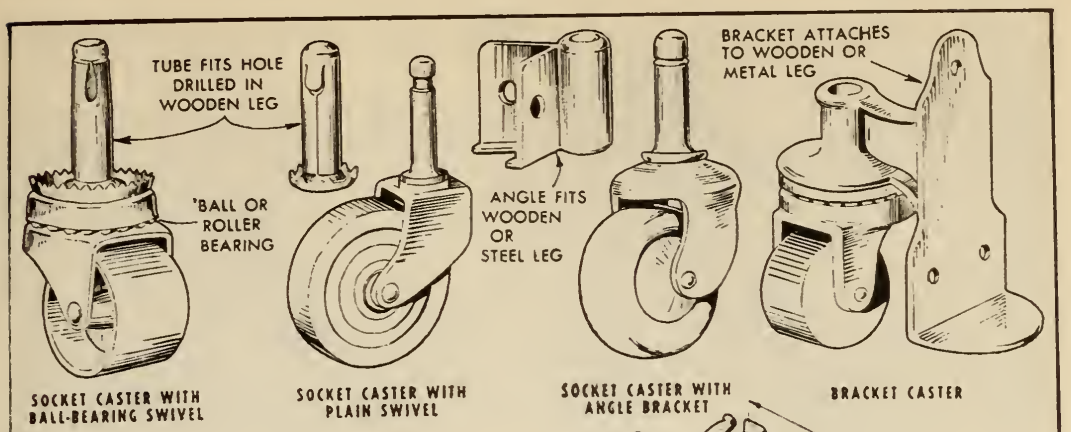


there is more clearance under the machine table, the handle bars can be made somewhat longer. The frame and platform are the same size and are cut from 1$\frac{1}{16}$-in. plywood. When plywood of this thickness is not readily obtainable, edge-glue strips of solid stock to give the required width. Use maple or oak for the links, as these parts are subjected to considerable stress. Be sure that they are the same length and that the holes are drilled the same distance apart on all six units, as otherwise the links will tend to bind when raising and lowering the platform. Four swiveling plate casters are specified, but in some cases it will be an advantage to use two swiveling casters at the front (handle) end and two plain, nonswiveling casters at the rear of the frame. This arrangement of the casters makes the dolly easier to maneuver in close quarters, especially when moving a heavy unit. When you move a large unit such as a bench be sure that it is balanced on the narrow width of the dolly. ★ ★ ★



Wheels for your POWER TOOLS

FEW HOME SHOPS are big enough to provide ample work area for several power tools. When the space is limited, such machines as the bandsaw, shaper and circular saw must be moved to accommodate long stock. At best this is a difficult job and may result in damage to the machine and also the shop floor. A dolly fitted with three or four swiveling casters enables the operator to move the machine to the required position with a minimum of time and effort. Caster wheels of the types shown should be at least 2 in. in dia. and, better, 2½ or 3 in. If your shop floor is concrete and rough in spots, nothing less than 3 or 3½-in. wheels should be used in order to permit easy rolling, Fig. 9. The best wheel for a concrete floor is a steel wheel having a rubber or laminated-leather tire, such as is used in the installation shown in Fig. 5. Plain steel wheels are a good second choice although they are noisy on rough concrete. Plastic and composition wheels are satisfactory only if the floor is fairly smooth.



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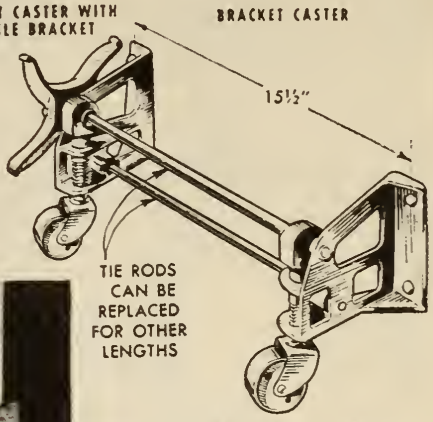
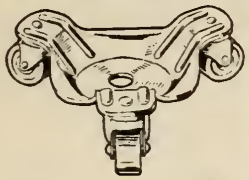
Casters for making power-tool dollies are available in a variety of styles and sizes. The average wheel size should be 3 in. for use on fairly smooth concrete floors. The retractable caster shown at the right is furnished as a unit having flat-faced brackets for bolting to any vertical surface




STOVE TRUCK CASTER

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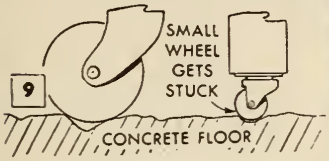

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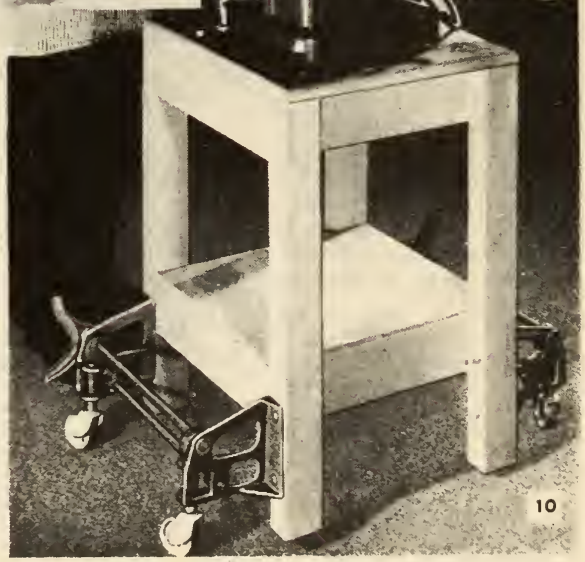
Probably the most useful style of wheel for a power-tool dolly is the plate caster, Fig. 3. This is available with wheels from 2 to 6 in. in dia. When the tool is mounted on a steel floor stand, the usual installation is to make a wooden framework which will fit under the lower shelf of the stand. The casters are then bolted to the framework. A typical installation, shown in Fig. 5, is made from 2 x 4-in. stock wedged between the legs of the stand as in Fig. 2. It must be fitted in place for assembly and cannot be removed without disassembling one side. The 4-in. wheels, Fig. 1, raise the stand legs about 1 in. above the floor when used under the 2 x 4-in. framework on the stand pictured. Some dollies made in this manner may require blocking to raise the stand or half-lapping of the frame to lower the stand to get the desired lift of ¾ or 1 in. above the floor.



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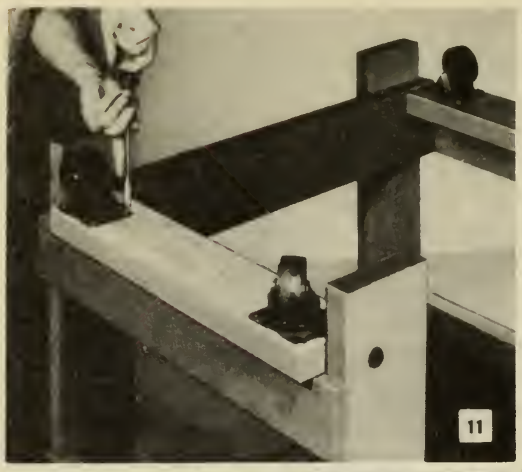
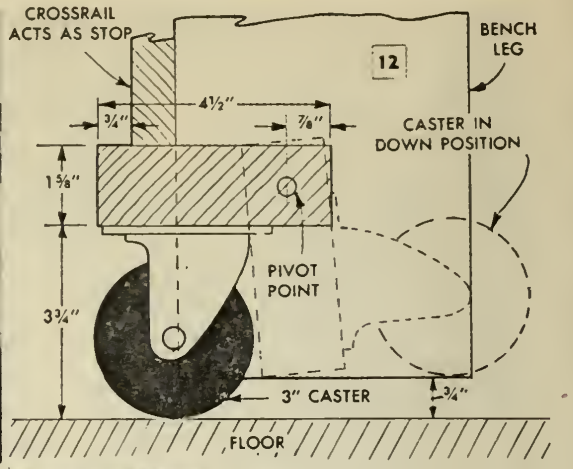
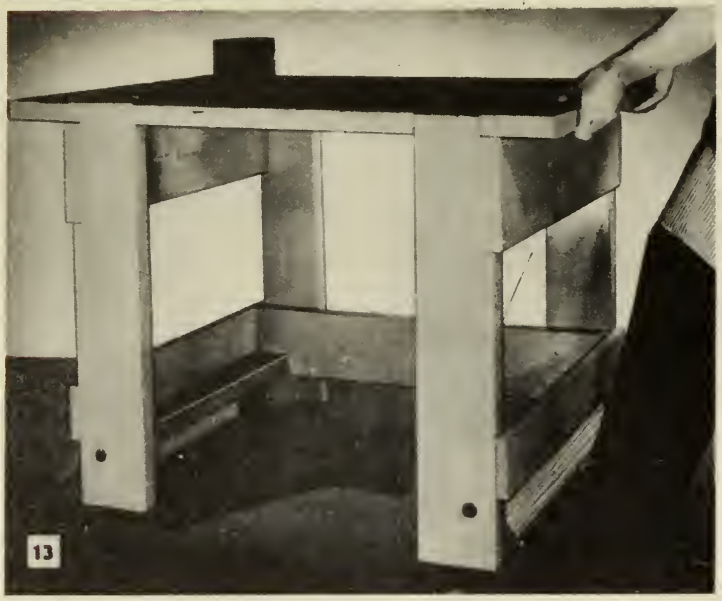
Although the retractable-caster units are best to use on a bench which permits attaching them inside the legs, they can be mounted on the outside of the legs as shown above







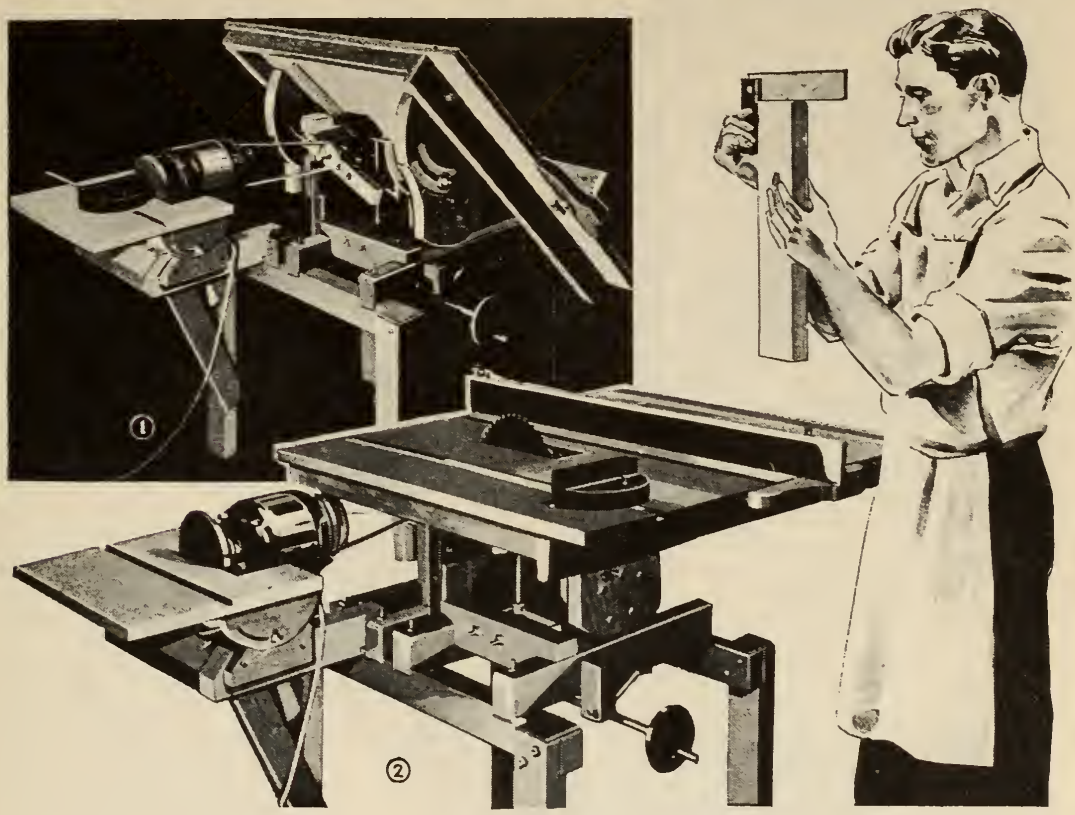
Simple retractable caster mounting can be made by pivoting a tilting bar between the legs of the machine stand. Casters are tilted to down position with foot

A slip-under style of stand is shown in Figs. 4 and 6. This can be dimensioned to serve a number of tools. The unit is readily slipped under the machine after first blocking up the rear legs with blocks a little thicker than the distance the caster unit raises the legs above the floor, Fig. 6. It will be noted that in both of these units the machine rests on the wheels at all times. The legs do not touch the floor. This is a practical mounting when used on an average concrete floor as the machine will not roll under normal operating conditions. On a smooth floor, the two units shown operate satisfactorily with two wheels only, substituting plain raising blocks for the other caster or casters. In a two-wheel installation, the machine must be tilted wheelbarrow-wise to move.

Retractable casters, Figs. 7, 8 and 10, make good installations for any light power tool. The best installation of this unit is on a long bench, since this permits fitting the casters inside the bench legs. However, an outside mounting, shown in Fig. 10, is quite satisfactory. This unit has an up-and-down movement of about ½ in. and is operated by a treadle, Fig. 8. Socket casters, Fig. 7, are the easiest to fit when you want to fit wheels directly to the legs of a wooden stand. The angle-bracket caster is especially suitable for plain angle-steel stands. The bracket caster is a useful mounting for attaching to existing legs without increasing the height of the installation. Normally, wooden or angle-steel legs can be sawed off to compensate for added lift of the casters.

For larger machine stands or a small wooden bench, the simple tilt-bar type of retractable mounting, Figs. 11, 12 and 13, is satisfactory. The unit shown uses four 3-in. plate casters fitted to the underside of a tilting bar pivoted on lag screws. To set the wheel position, the end of the bench is raised slightly, Fig. 13, and the tilt bar is moved in or out with the foot. Two casters only can be used if desired, making a wheelbarrow-type unit which is readily wheeled to any location. ★ ★ ★

CIRCULAR SAW SANDER-UNIT

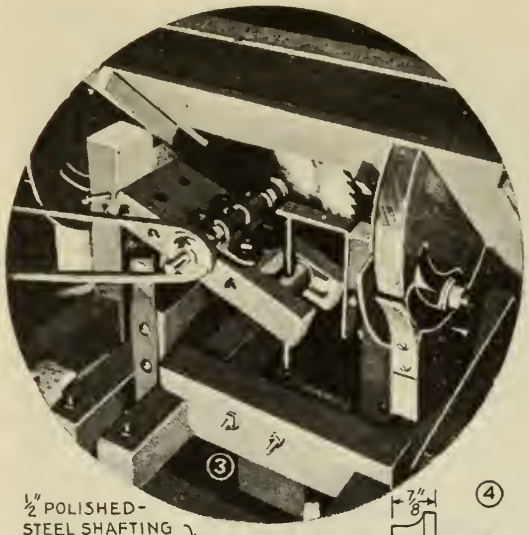


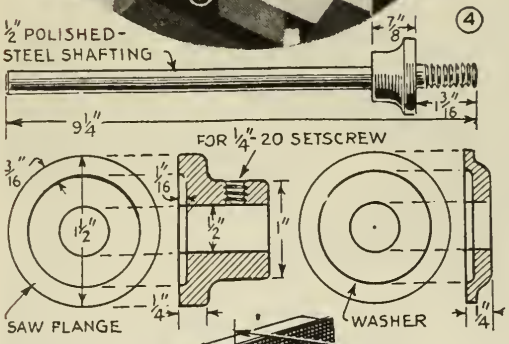
THIS combination workshop unit features an 8-in. saw having a 30 by 36-in. table that will tilt 45 deg., Fig. 1, a swinging saw mandrel, and a direct-drive disk sander. A ⅓-hp. motor operates both machines as shown in Fig. 2.

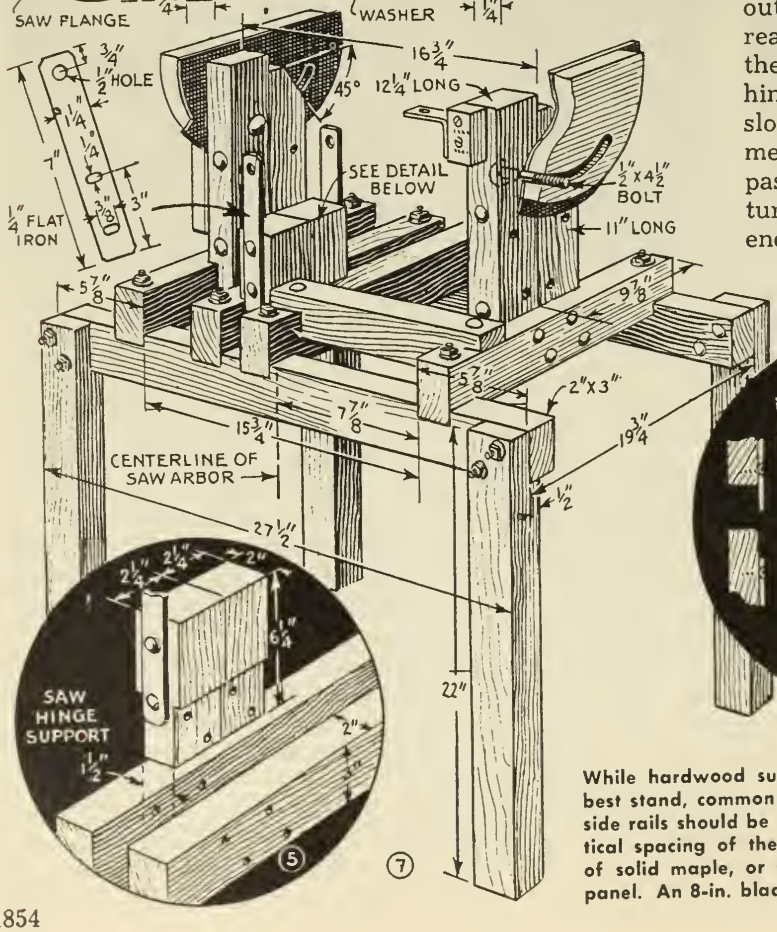
Construction begins with the stand. From Fig. 7 you can see clearly how it is put together with ¼-in. carriage bolts. All stock measures 2 by 3 in., and note that the upper ends of the legs are notched for rigidity. The position of the two-piece front and rear trunnion supports can be marked at this time, and the holes drilled, but it is best not to bolt them to the stand until after the complete trunnion assembly has been attached. The saw hinge support, detailed in Fig. 5, is set 4⅜ in. in from the end of the rails between which it is bolted. Now for the trunnions and their slides. Make these of ¾-in. birch or maple and take pains in laying them out from the pattern given in Fig. 8. The concave edge of the slide must make a perfect rubbing fit with the trunnion, and the curved bolt slot should equal the curve of the trunnion so that the latter will not bind. To the back side of each trunnion and its slide, guides of ⅛-in. hard-pressed board are fitted as shown in Fig. 6. These are cut as indicated to overhang the edge of the trunnions 1 in., forming a lip which overlaps the slide. Use flathead screws for attaching the guides, countersinking the heads flush with the surface. The trunnion-bolt holes through the supports are bored 3$\frac{5}{16}$ in. down from the top. Holes for bolting the slides to the trunnion supports are located by placing the trunnion on its bolt and then with a thin cardboard shim between the slide and the support, center the slide beneath it and clamp the latter temporarily to the support. When you have the slide adjusted so that the trunnion works smoothly, drill four holes through both pieces for ¼-in. bolts. A semi-hard brass strap attached to the edge of each slide to bear against the edge of the trunnion (see side view Fig. 8) takes up the thrust of the table when tilted. In place of the cardboard, thin washers are

used on the bolts to provide the necessary clearance.

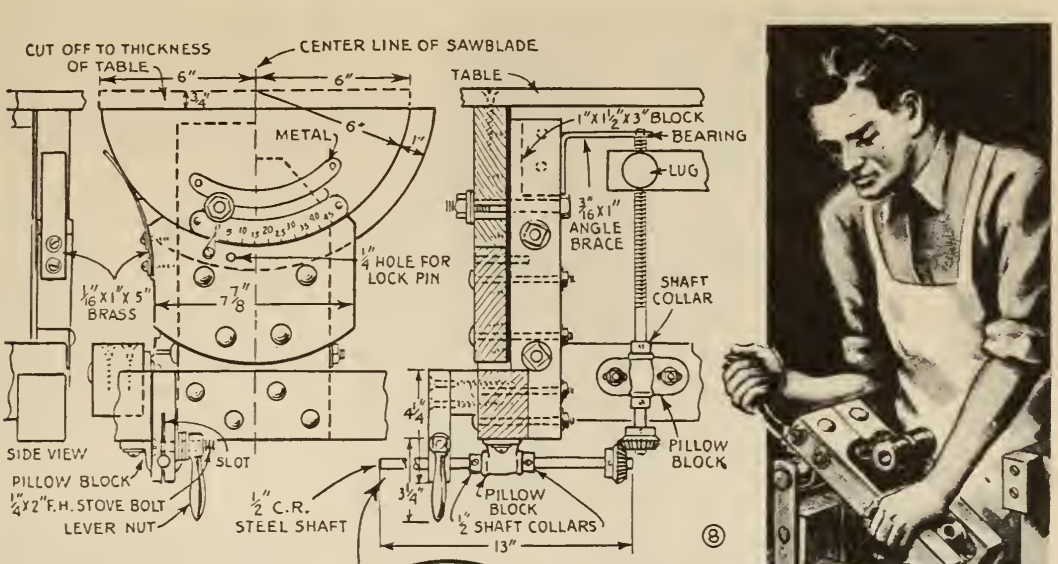
Fig. 3 gives a general idea of how the blade is raised and lowered. Essentially, it consists of a swinging mandrel which is elevated by a lug traveling on a vertical spindle. Fig. 10 shows how the block is made up of two pieces of oak which are recessed to house the tenoned ends of a turned lug. Dimensions for the block and the lug are given in Fig. 11. The latter should move freely in the routed opening with very little side play. Standard bronze-bushed pillow blocks set end to end serve as a bearing for the saw mandrel and as a hanger for pivoting the block between the arms of the saw hinge support. See Figs. 5 and 7. The exact position for mounting the pillow blocks is given in Fig. 11. To align each pair of blocks it may be necessary to shim them with thin pieces of metal. Fig. 4 details the saw mandrel which can be made by threading the end of a length of standard steel shafting and fitting it with a flange. Collars are used on the mandrel at each end of the bearing. The mandrel block must swing without side play and for this reason the holes in one of the flat-iron arms of the hinge support should be slotted to permit adjustment. The vertical spindle passing through the lug is turned down at the upper end to engage a hole in an

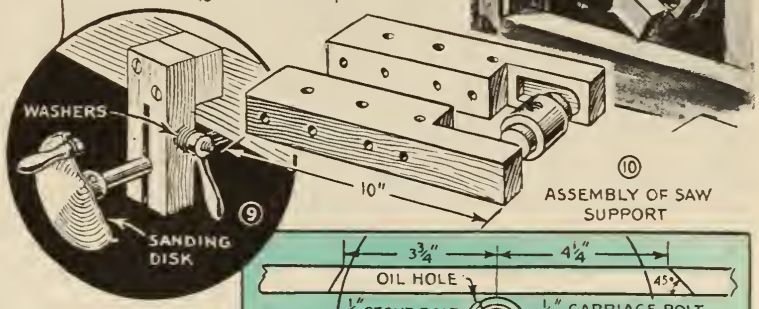




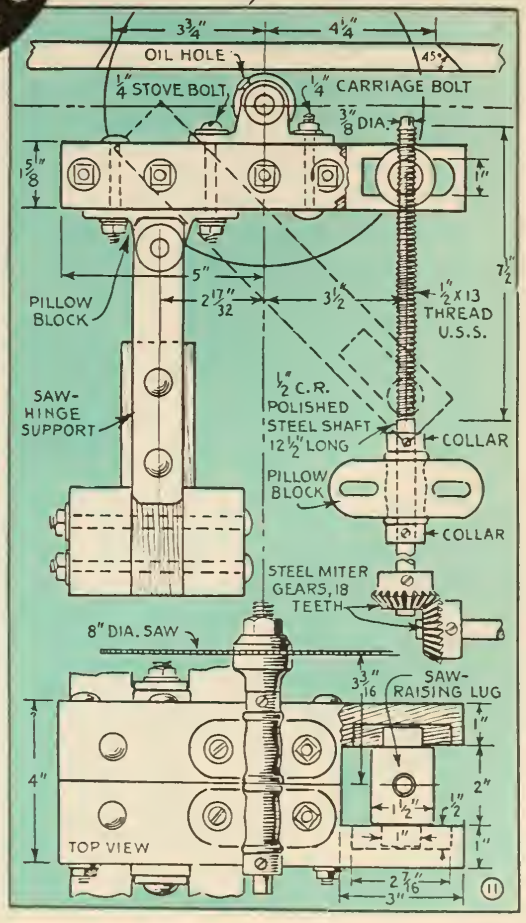


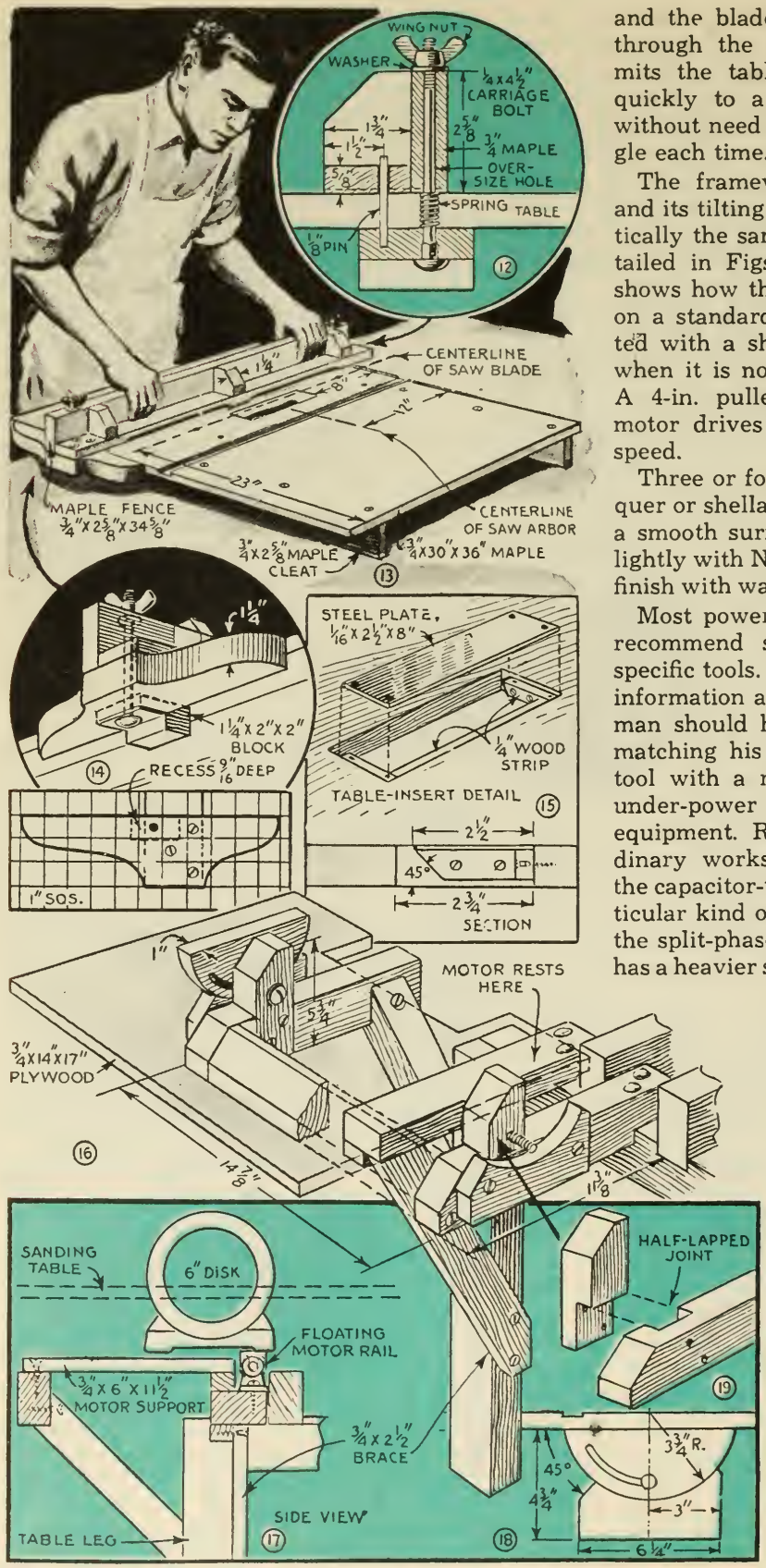
While hardwood such as birch or oak makes the best stand, common fir or white pine will do. Both side rails should be notched at once to assure identical spacing of the cross rails. The table can be of solid maple, or simplified by using a plywood panel. An 8-in. blade gives maximum cut of 2½ in.





L-shape bracket attached to the trunnion support, while at the bottom it is held by a pillow block which is fastened to a cross rail. See side view in Fig. 8. By means of steel miter gears the shaft is extended through a second pillow block to the front of the stand and fitted with a handwheel which can be made from a small sanding disk. A simple arrangement for locking the shaft is shown in Fig. 9. Now for the table and fence. The former is built up of random widths of maple, using dowels and glue. The blade opening is cut to the size given in Fig. 15 and is fitted with cleats to support a metal insert plate. After this, ⅜ by ¾-in. grooves are cut in the surface of each side of the blade opening to accommodate a standard miter gauge and then cleats are screwed to the underside as in Fig. 13. The underside of the table above the 2-in. mandrel pulley must be recessed to clear the latter when the blade is raised to its maximum height. The table is attached to each trunnion with three flathead screws, aligning the grooves so that they are parallel with the saw blade. The T-square fence is undercut to ride the table at three points. Figs. 12 and 14 show how bolts and wing nuts are fitted at the front and rear to clamp it in position. With a T-bevel set at known angles, the scale on the front trunnion can be marked for degrees by holding the bevel in contact with the table





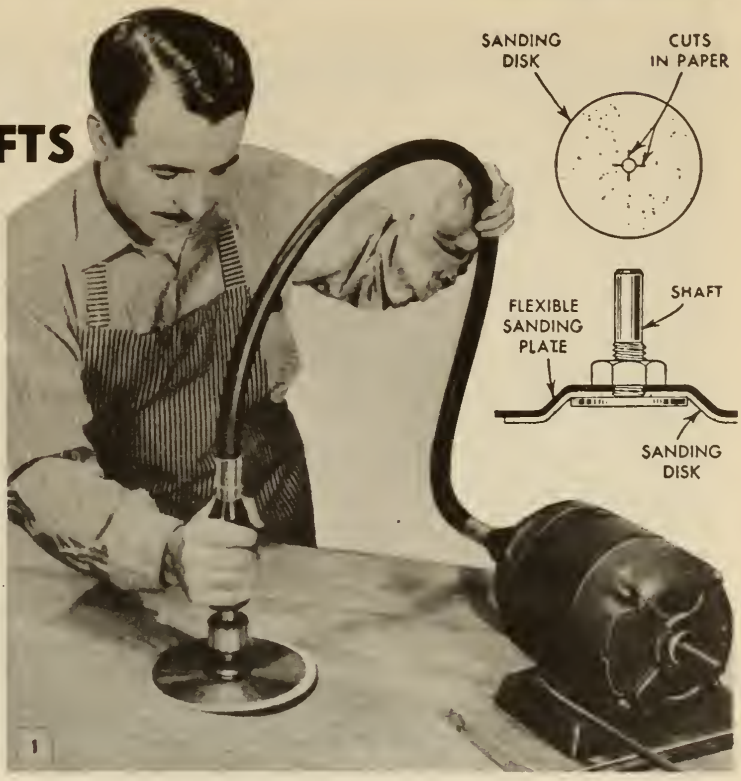
and the blade. A lock pin fitted through the front trunnion permits the table to be returned quickly to a horizontal position without need for checking the angle each time.

The framework of the sander and its tilting table, which is practically the same as the saw, is detailed in Figs. 16 to 19. Fig. 17 shows how the motor is mounted on a standard motor rail and fitted with a shelf on which to set when it is not belted to the saw. A 4-in. pulley on a 1750-r.p.m. motor drives the saw at correct speed.

Three or four coats of clear lacquer or shellac will give the tables a smooth surface. Rub each coat lightly with No. 5-0 sandpaper and finish with wax.

Most power-tool manufacturers recommend suitable motors for specific tools. Using this source of information as a guide, the craftsman should have no difficulty in matching his newly made power tool with a motor that does not under-power or over-power the equipment. Recommended for ordinary workshop power tools is the capacitor-type motor. This particular kind of motor is similar to the split-phase type except that it has a heavier starting winding connected in series with a condenser. The capacitor-type motor is easily recognized by the extra case on the top or the side. Repulsion-induction motors are excellent for heavy-duty work. Avoid long, light-extension cords in wiring the power tool in its permanent location. The flimsy light cord is not only unsafe, but it robs your motor of as much as 25 percent of the motor's rated power.

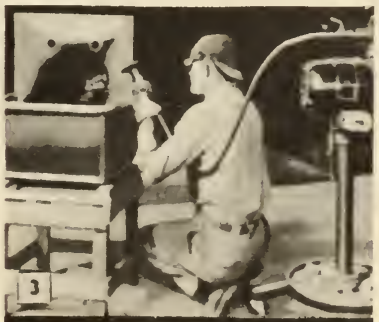
FLEXIBLE-SHAFTS



A FLEXIBLE SHAFT combines both the power and uses of many different tools in a handy portable unit. With it, you can carve, drill, sand, rout, buff, wire-brush, saw, polish and grind simply by using the necessary accessories on the projecting end of the shaft at the handpiece, Figs. 2 to 4 and 7 to 9 inclusive. Large flexible shafts are widely used in industry for such heavy operations as removing rust and scale, grinding welds, polishing large surfaces of metal and snagging castings.

Flexible shafts usually are rated large or small according to the size of the shaft, or core, as it is called. A large flexible shaft is one having a core 5/16 in. in diameter or larger, while a small shaft is one having a 1/8 to 1/4-in. core. The large shafts will transmit power for the heaviest work that can be done with hand-held tools, and small shafts are especially suited to use with tiny rotary files, grinding wheels and polishers, which must be rotated at extremely high speeds. The small shafts are quite flexible and will operate efficiently when curved to a comparatively short radius.

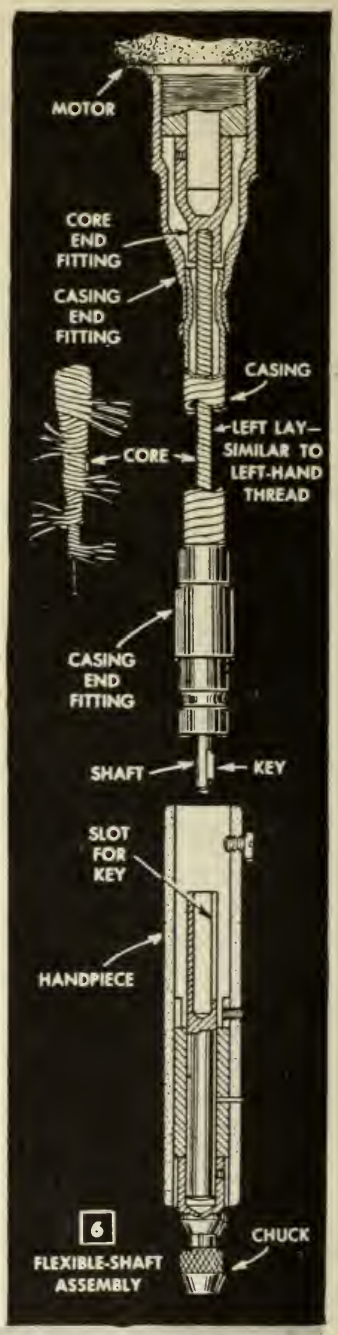
SANDING



GRINDING

POLISHING

5

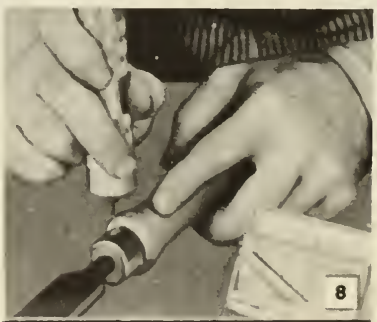


6 FLEXIBLE-SHAFT ASSEMBLY

A flexible shaft consists of a stationary casing and a core, which rotates inside the casing. The core, in both the large and small sizes, is a precision-built unit consisting of layers of spring-steel piano wire wound to produce an alternating right and left-hand pitch, as in Fig. 6. The pitch of the outside layer determines the direction in which the shaft should be rotated. Most shafts are left pitch and should be operated in a clockwise direction, as this movement tends to tighten the outer winding of wire. Clockwise direction of rotation is common to lathes, drill presses and also to most types of motors. It is possible to reverse the direction of rotation of the shaft where the work load will at no time exceed half the power rating.

Although some casings consist only of a continuous spring-steel strip wound spirally with interlocking edges, most of the better-quality shafts are fitted with casings of braided wire and molded rubber or fabric coverings which give somewhat greater flexibility and ease of handling. Small shafts designed for high speeds often have a spiral inner liner which fits loosely over the core and has the effect

7 BUFFING


8 DRILLING

9 CARVING

10 FLEXIBLE SHAFT DATA

① CORE DIAMETER	② HP. AT 1750 R.P.M.	③ MAXIMUM SPEED	④ MINIMUM RADIUS	⑤ LARGEST GRINDING WHEEL	⑥ DEFLECTION PER FT. OF LENGTH	SPECIFIC USES
1/16"	1/100	25,000 R.P.M.	4"	½" DIA.	100°	VERY DELICATE WORK ONLY —LIMITED USES
1/8"	1/18	18,000 R.P.M.	5"	1" DIA.	70°	ALL KINDS OF CRAFTWORK WHERE FLEXIBILITY AND CONTROL ARE MORE IMPORTANT THAN POWER
3/16"	1/10	12,000 R.P.M.	6"	2" DIA.	40°	
1/4"	1/6	8,000 R.P.M.	6"	3" DIA.	30°	LIGHT DUTY CONTINUOUS BUFFING, POLISHING AND GRINDING. SINGLE OR MULTIPLE-SPEED UNITS
5/16"	1/4	7,000 R.P.M.	7"	3½" DIA.	22°	
3/8"	1/3	6,000 R.P.M.	8"	4" DIA.	18°	USUALLY 4-SPEED UNITS. USED FOR ALL KINDS OF MEDIUM TO HEAVY SANDING, GRINDING, ETC., PREFERABLY AT A FIXED LOCATION
7/16"	1/2	5,000 R.P.M.	10"	5" DIA.	15°	
½"	3/4	4,200 R.P.M.	10"	6" DIA.	11°	

① General average values — cores of the same dia. may vary in canstruction so that values given are only an all-around average.

② This column lists largest motor generally used. Safety factor is about 4. Motor power can be increased proportionately with increase in shaft speed. Example, ¼-in. core can handle 1/6 hp. at 1750 r.p.m., or 1/3 hp. at 3600 r.p.m.

③ Main consideration is the prevention of shaft overheating which occurs if shaft runs much over 500 surface feet per minute. Most shafts under ¼-in. dia. are powered with universal motors and will run much slower than "no load" speed of motor.

④ Values given are normal for good power transmission but shafts can be worked at sharper curves for occasional work.

⑤ These diameters are based on what the shaft will stand and also on how fast any grinding wheel can be operated with safety. Wire brushes, buffs and sanding disks can be larger.

⑥ This column shows deflection or "windup" of shaft under full load. A ⅛-in. shaft, for example, will deflect 70 deg. per foot. If the shaft is 3 ft. long, total deflection will be 210 deg. or a little over ½ of a full turn.

SPINDLE-TYPE HANDPIECE

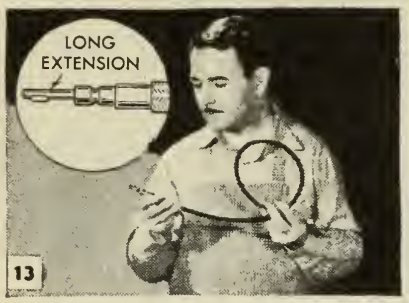
KEY-TYPE CHUCK

11 COLLET CHUCK

of reducing friction. Connecting members of the shaft are press-fitted into the casing and are designed to permit coupling directly to the motor at one end and to the handpiece at the other. When the shaft is operated straight or nearly so, Fig. 12, the end of the core extends only slightly. Fig. 13 shows how the core extends when the shaft is flexed. One end of the core is fixed in the connector and the other end is splined or keyed to the connector to permit movement in and out when the shaft is operated on a comparatively short radius. On some shafts, this movement is taken up at the motor end, the handpiece end being fixed. Shafts of this type can be attached directly to a motor shaft, Fig. 1, or to a drill press, Fig. 18. When connected to the drill press, as in Fig. 18, it should be kept in mind that the torque of the drill-press spindle far exceeds the load limit of the shaft.

Simplified data on the common sizes of flexible shafts is given in the table, Fig. 10. The data given is not exact but is average for all shafts. If you want a shaft for light craftwork, such as modelmaking, the ⅛ to 3/16-in. core size is a good selection. For heavy grinding, buffing, and wire-brushing, the 3/8-in. core is sufficiently strong to take the torque of motors up to ½ hp. For the small shaft, the handiest length is 3 to 3½ ft. and the large shaft should be 5 to 6 ft. long. Such shafts are available as motor-and-shaft units with variable speeds, and also for direct attachment to motors, or any spindle of proper size and speed.

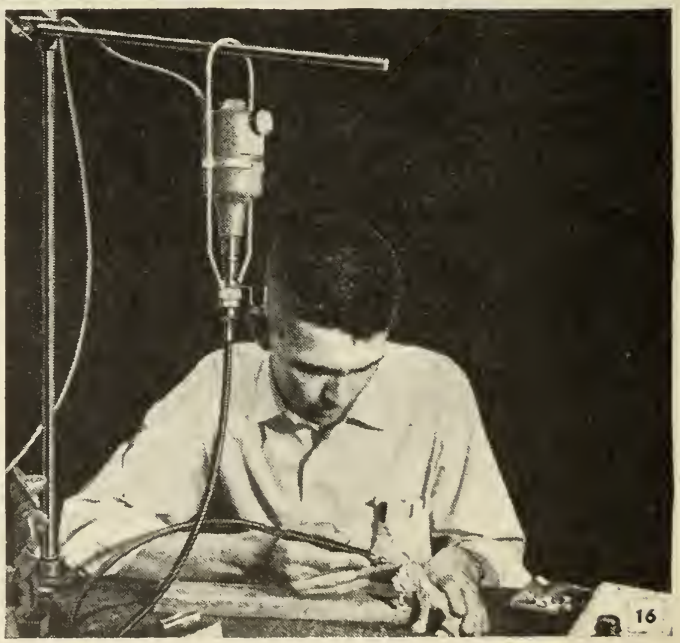
The business end of the flexible shaft is the handpiece and, in the larger units, many different types of handpieces are



available. The straight, spindle-type handpiece, Fig. 11, usually is supplied with the large shaft. Flanges for this handpiece permit mounting accessories which have a center hole and can be held between the flanges. A hand-closing chuck having a threaded shank, which can be screwed onto the handpiece spindle, is useful for holding drills and any other tools having shanks of a diameter within the capacity of the chuck. Grinding wheels should not exceed the diameter given in the table, but such accessories as cloth buffs and sanding disks can exceed the grinding-wheel diameters by as much as 25 percent. A common handpiece supplied with the small shafts is either a collet chuck or a chuck tightened by means of a special key or spanner-type wrench, Fig. 11. These usually have a capacity of $\frac{3}{32}$ or $\frac{1}{8}$ in., adapters being available for holding the in-between sizes. Such chucks are ideally suited to driving mounted grinding wheels, wire brushes and small rotary files. The key-type chuck is available in either sleeve-bearing or ball-bearing construction, but collet chucks usually are supplied only with sleeve bearings. Right-angle handpieces are supplied for use with the heavy shafts. Figs. 2 and 4 show this type of handpiece in use.

MOTOR MOUNTS

Motors for powering small flexible shafts should be supported with a swivel joint for ease in manipulation. Fig. 14 shows a motor hanging from a vertical arm which is held by a toolbox. For portability, the motor can be carried on a shoulder strap as in Fig. 15. Bench-work requires that motor be supported overhead. See Fig. 16



Power take-off for driving flexible shaft can be made from drill-press spindle, as above, or from lathe motor, as at the left

Core of shaft is cleaned and lubricated at regular intervals

Proper installation of the flexible-shaft unit is necessary if you are to get the most out of this versatile tool. One of the handiest arrangements for using a small shaft-and-motor unit is that in Fig. 5. On such units, the motor is provided with a bail or hook so it can be hung at some point above the work. In this case, a swinging arm mounted on the bench tool panel makes it possible to use the shaft unit at any point on the bench top. Other applications, using the same motor unit, are shown in Figs. 14, 15 and 16. Similar units are available with larger shafts and motors. The larger units also are supplied with a special floor stand as in Figs. 2 and 3. On these units, the motor base swivels, permitting the unit to follow the movements of the operator without undue flexing of the shaft. In small commercial shops and home workshops, the larger shafts can be set up as in Fig. 1, the motor being bolted to a wooden base.

The same type of shaft as that in Fig. 1 is shown in a somewhat different adaptation in Fig. 17 where it is being driven by the lathe motor and is used to drill index holes in a wood turning. In the setup shown in Fig. 1, maximum freedom of movement is obtained with the end of the motor shaft toward the operator, a trick to remember when operating a flexible shaft with the motor mounted on a stationary base. Disk-sanding is done with a special flexible disk constructed as shown in the details in Fig. 1. The abrasive disk usually is not attached to the backing disk with adhesive but is held in place by a recessed flange. In operating a disk of this type on large flat surfaces, make a one-way stroke with the leading edge of the disk lifted slightly as shown. In this way, the trailing edge will not leave scratches on the work. A lamb's-wool bonnet for polishing can be fitted over this type of disk.

Flexible shafts used intermittently need little servicing, except that care should be taken to make sure that the shaft does not run without lubricant. Dismantle the shaft at regular intervals and clean all the parts with a solvent as in Fig. 19. When assembling after cleaning, renew the lubricant with the grade specified by the manufacturer. Ball-bearing handpieces usually are provided with separate oilholes having ball closures. These handpieces should be lubricated at regular intervals with a medium machine oil or any special lubricant specified by the manufacturer.

(Certain photos courtesy R. G. Haskins Co., Delta Mfg. Co., Foredom Electric Co., and The Dumore Co.)

Power Your Tools With a FLEXIBLE SHAFT

By C. W. Woodson

FLEXIBLE SHAFT applications cover a wide range of equipment from the most delicately manipulated hand tools, running at extremely high speeds for precision work, to the heavy-duty grinding or snagging wheel built for rough, hard use where the service is severe. For light work, with a suitable handpiece mounting a key-operated chuck, the flexible shaft will handle a variety of tools for drilling, grinding, carving, sanding and other operations, Figs. 1 and 5. With the proper combination of end fittings, on both the shaft and its casing, special equipment, such as the tool-post grinder, Fig. 2, can be driven at the required speed for internal grinding, making the tool an indispensable accessory to the metal lathe. A similar accessory, but for external grinding, is shown in Fig. 8.

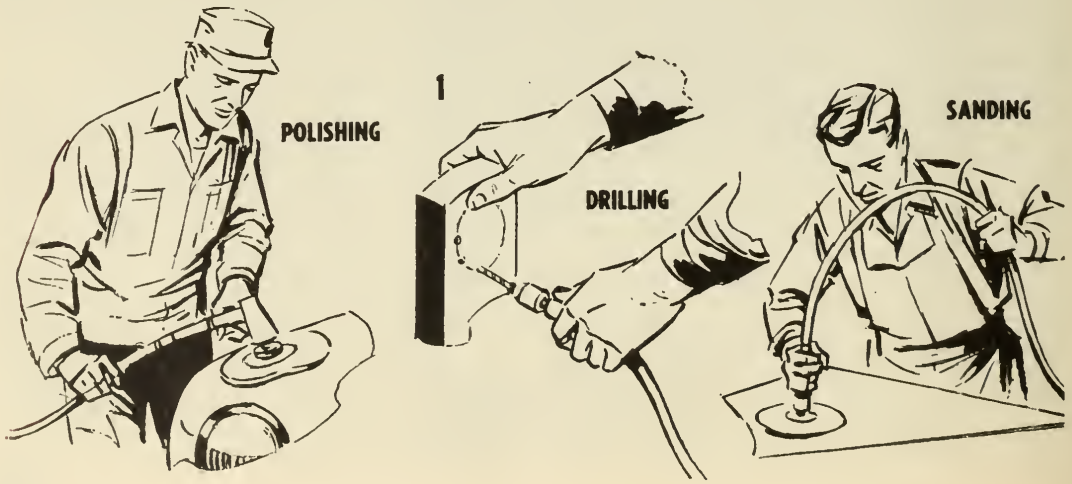
Flexible-Shaft Applications

Covering a wide field, flexible shafts are made in various sizes, for light work where extremely high speeds are needed, to shaft sizes transmitting power for the heaviest type of work that can be done with hand-held tools. Regular types of flexible shafts are built up of one or more superimposed layers of wire with a single wire, or mandrel, in the center. Fig. 7, details A, B and C, indicates how shafts of various sizes are made up and how the pitch direction of successive layers alternate.

Different characteristics of the flexible shaft are determined by varying the size and grade of the individual wires, the number of strands and number of layers, the degree of pitch as well as the winding tension and in some cases, heat treatment after the shafts are wound. These features largely determine the transverse flexibility, or degree to which a shaft can be flexed, Fig. 3, while under load. Torsional stiffness, or twisting under load, is affected as well as the running torque of the shaft.

"Lay" of Shaft

The "lay" of the shaft is either "right-lay" or "left-lay" as determined by the pitch direction of its outer layer of wires. A right-lay shaft is one in which the outer layer has the same pitch direction as a right-hand screw thread, while the outer layer of a left-lay shaft corresponds to a left-hand thread, Fig. 4. For maximum efficiency in transmitting power, the flexible shaft is wound for rotating in one direction only. The pitch direction of the outer layer of wires determines the direction of rotation for best results. Fig. 8 indicates how the direction of rotation is determined and the correct lay of shaft to use for each direction. For driving in a clockwise direction a left-lay shaft should be used. Direction of rotation is determined from the power-source end of the shaft, Fig. 6. Shafts of both right-lay and left-lay types are made in a wide range of sizes and care should be used in selecting one to correspond with the running direction of the motor and design of the tools to be used, Fig. 6. Clockwise direction of rotation is most frequently applied. The average small motor runs in a clockwise direction.



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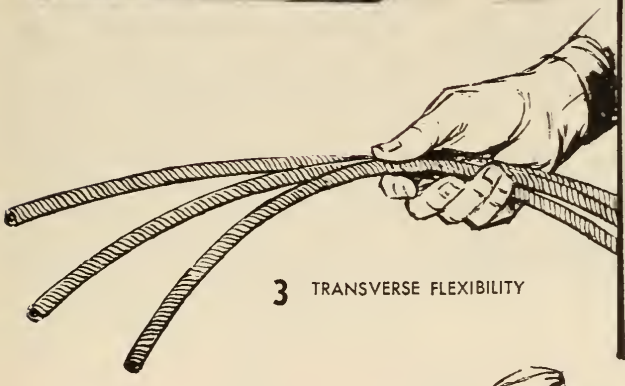
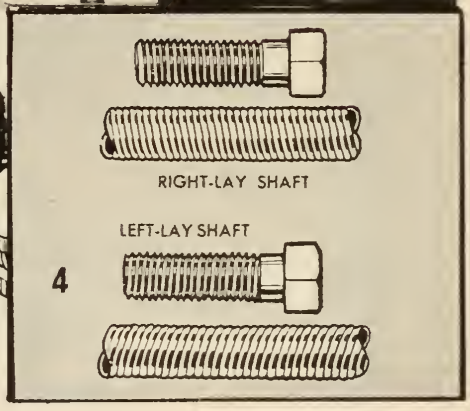
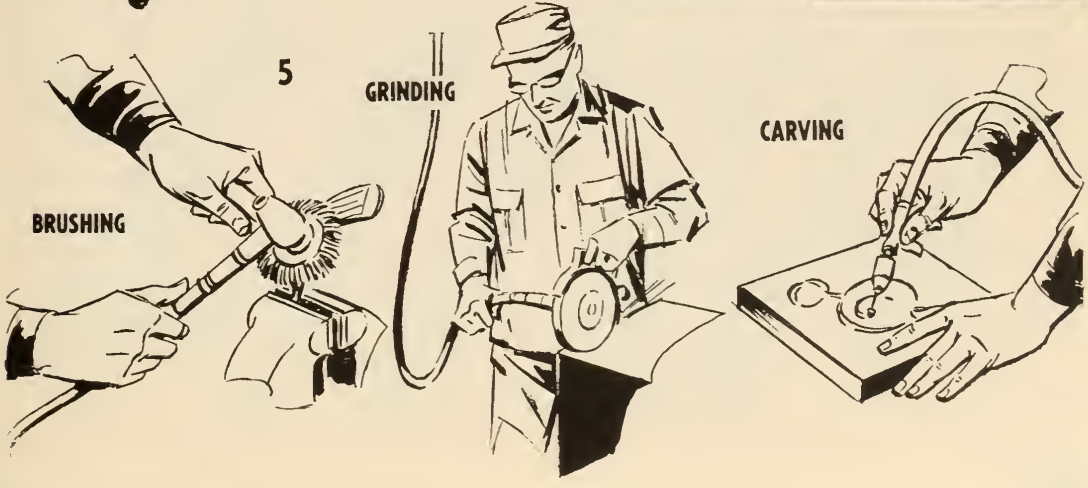

3 TRANSVERSE FLEXIBILITY


RIGHT-LAY SHAFT
LEFT-LAY SHAFT
4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GRINDING
BRUSHING
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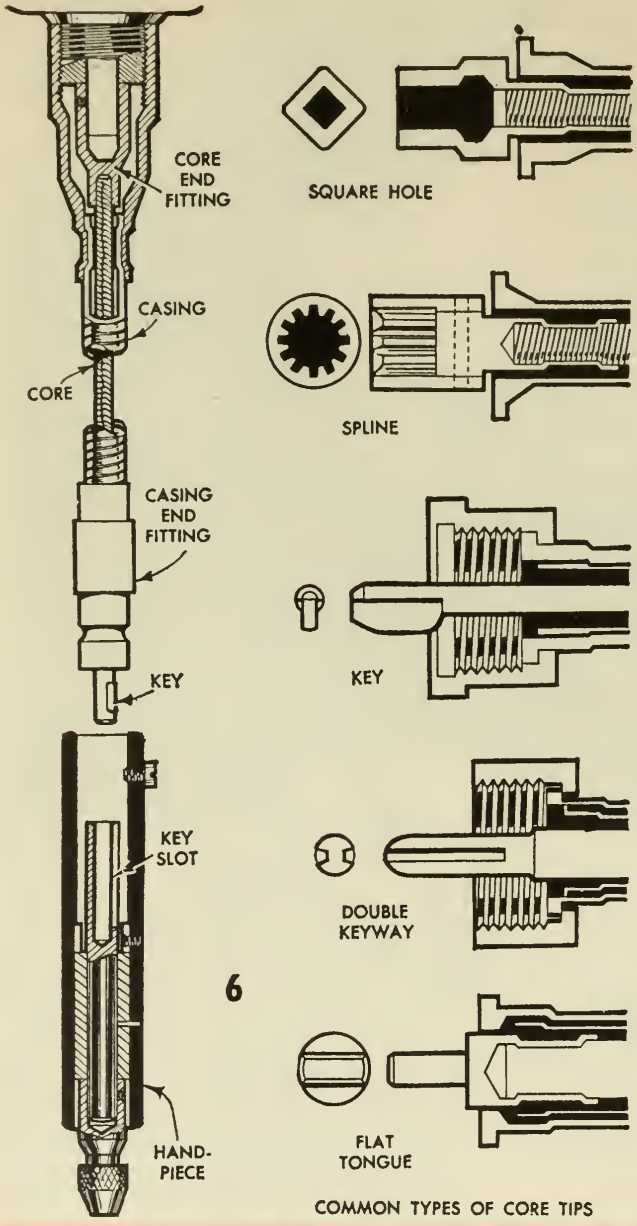


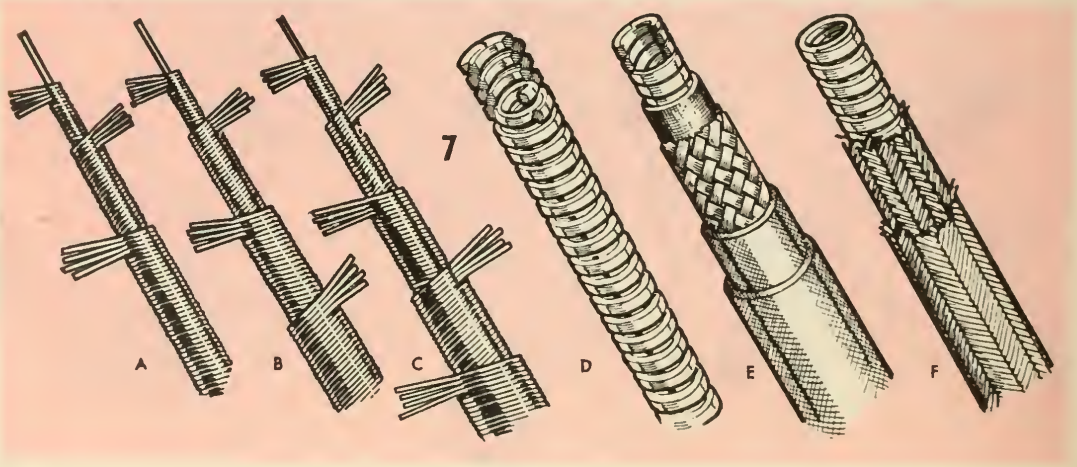
6 COMMON TYPES OF CORE TIPS

Torque, or twisting force which the shaft will be called on to transmit, is the principal factor in selecting a flexible shaft because each size has a definite torque-load capacity. A distinct advantage is to be gained by running a shaft at the highest speed which the job at hand will permit. Ordinarily, speeds of 1750 to 3600 r.p.m. are recommended as suitable for flexible-shaft operation. In many applications shafts operate from 600 to 12,000 r.p.m.

The use of gearing, where standard motors are used, is common practice where a decrease or increase of speed is desirable. In each case the flexible shaft is always run at highest practical speed. Fig. 9 illustrates how the gearing is located so that the shaft operates at the highest speed.

The flexible casing is made in three general types: metallic, fabric covered and rubber covered. The casing enables the shaft to run true and operate smoothly. It also prevents it from helixing, or looping, under torsional strain. The casing also protects the shaft from moisture, dust, grit and external injury and retains the lubricant.

Two and four-wire metallic casings meet requirements for the general use of power-driven flexible shaft applications, Fig. 7, detail D, E and F. The two-wire casings are made of two formed wires accurately machine-wound. The inner wire is half round in section and the outer wire triangular, its shape conforming to the inner-wire contour. This facilitates bending freely while maintaining the contact of adjacent wires. The two-wire casings are particularly suited



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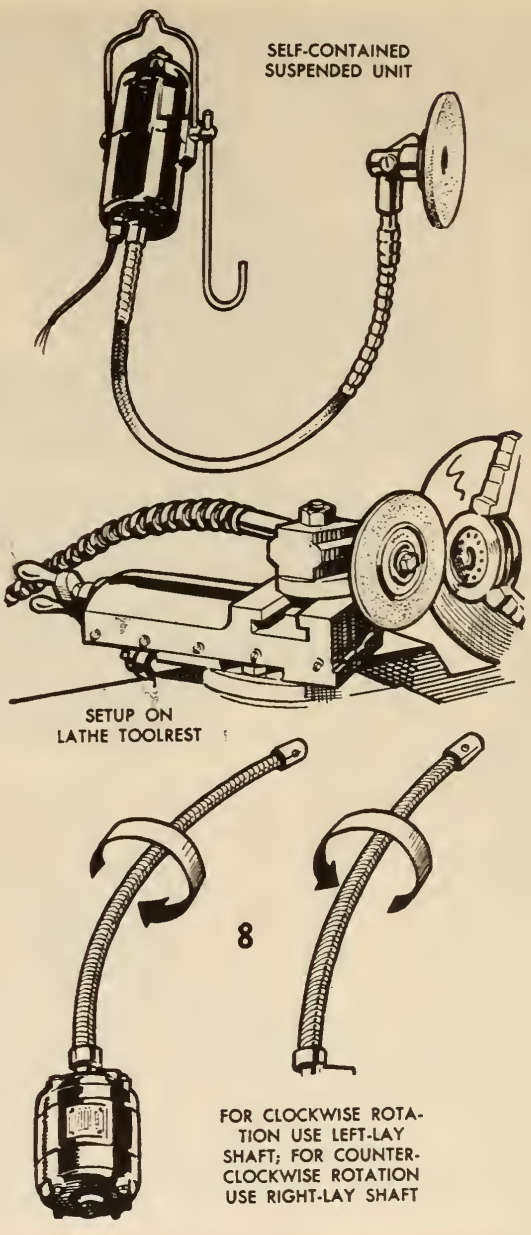
for portable tool applications where the shaft will be flexed more or less constantly. The four-wire casings are similar in construction but are wound four wires at a time instead of two. This makes a longer pitch, stiffening and strengthening the casing.

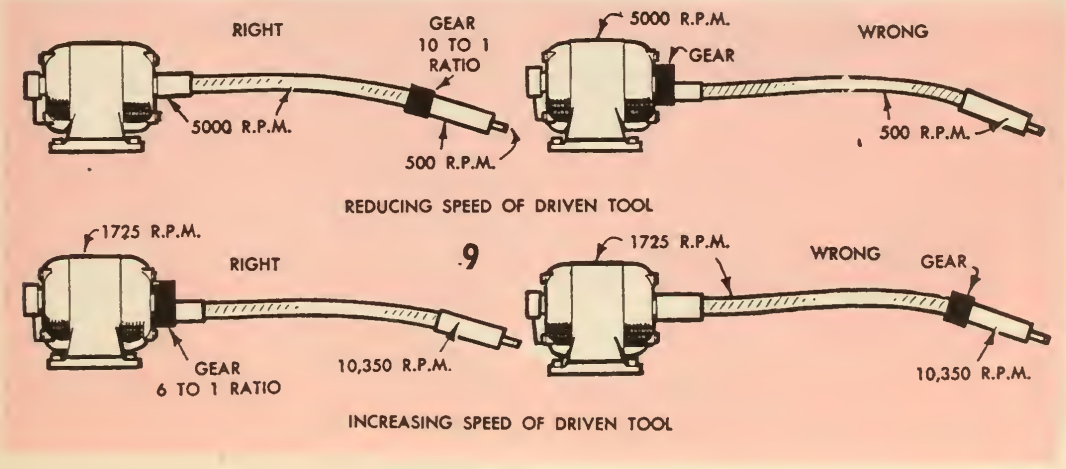
The interlocked type metallic casing is a single, continuous steel strip formed so that the adjacent turns are interlocked and when the interlocked joints are packed, usually with asbestos, the flexible casing is grease tight. Connecting end pieces of the shaft are press-fitted into the casing for direct connection to the motor at one end and the handpiece at the other. When the flexible shaft is operated in a straight position, the end of the core protrudes only slightly but when flexed the core protrudes considerably farther. To allow for this endwise movement the core is fixed on one end to the connector and is splined or keyed in the handpiece on the other, Fig. 6.

Fabric covered casing, Fig. 7, detail F, is very flexible in the smaller sizes. It is comparatively light in weight and is generally used on portable flexible-shaft machines. The rubber covered casing, Fig. 7, E, is generally a heavy-duty type on shafts designed for hard service. The casing is oil and watertight and offers maximum resistance to abrasion and stretching.

Always be sure the shaft rotates freely before starting. Also properly engage the end fittings and the core tips, Fig. 6, when setting up any special type of assembly. The flexible-shaft handpiece is made in different types for holding a large variety of tools. Suspended units, Fig. 8, consisting of motor, shaft and angle head, are widely used in industry.

Periodic lubrication of the shaft is necessary, the frequency of lubrication depending to some extent on the nature of the service. Where the shaft is operated for long periods with considerable flexing during operation it should be lubricated more often than for less service. ★ ★ ★





OPAQUE SHOWS FOR

A PROJECTOR is an optical device for enlarging opaque copy and projecting it on a wall, screen or sheet of white paper. Artists, sign writers and many craftsmen find a projector very useful. To use it, fasten the drawing, picture or clipping to a copy board, place the board in the projector box, snap the switch and there's your picture—any size you want it with only slight adjust-

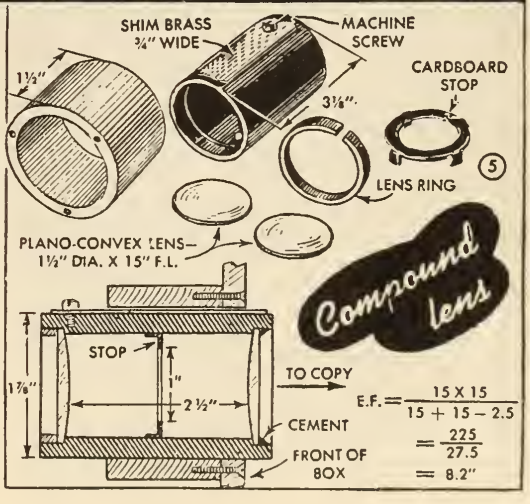
	SINGLE LENS	COMPOUND LENS	PROJECTOR LENS	CAMERA LENS
TYPE OF LENS	PLANO CONVEX DOUBLE CONVEX ACHROMAT	S E.F.= $\frac{F \times F}{F+F-S}$		
FIELD	TO COPY 20° PLANO-CONVEX LENS	20°	25°	50°
DISTORTION	HEAVY PINCUSHION DISTORTION—ABOUT ¼" TO ⅜" IN 12" AT IMAGE ¼" 12"	VERY SLIGHT DISTORTION—NOT OVER 1/32" IN 12" AT IMAGE	SLIGHT DISTORTION ABOUT 1/16" IN 12" AT IMAGE	NO DISTORTION
ILLUM	FAIR ILLUMINATION. WORKS BEST AT F:11 TO F:16	GOOD ILLUMINATION. WORKS AT F:8	EXCELLENT ILLUMINATION. WORKS AT F:4	GOOD TO EXCELLENT. WORKS AT F:4 TO F:8
REMARKS	POOREST TYPE OF LENS AND SHOULD BE USED ONLY FOR JUVENILE PLAY PROJECTORS. SINGLE ACHROMATIC LENSES ARE NO BETTER THAN PLANO OR DOUBLE CONVEX ②	BEST INEXPENSIVE TYPE. ONLY FAULT IS NARROW FIELD. SHOULD BE ABOUT 8" EQUIVALENT FOCAL LENGTH (E.F.). COST OF LENSES 1½" DIAMETER ABOUT 20c EACH	BEST TYPE FOR LONG THROWS OR WHERE STRONG ILLUMINATION IS NEEDED. COST IN RACK-AND-PINION MOUNT ABOUT $15. FOCAL LENGTH SHOULD NOT BE SHORTER THAN 6½"	BEST ALL-PURPOSE LENS. RAPID RECTILINEAR TYPE RECOMMENDED IN VIEW OF LOW COST (ABOUT $3). OTHER TYPES (ANASTIGMATS) ARE TOO EXPENSIVE FOR GENERAL USE

PROJECTOR DRAWINGS COPYING

ments of the copy board and lens. With minor changes in design a projector works equally well when used in the horizontal position, Figs. 1 and 3, for projecting pictures on the wall or a screen, or in the vertical position, Fig. 4, where it is used for projecting images onto an easel or drawing board so they can be traced in outline or in full detail.

General lens terms: The lens is the heart of the projector. Before discussing lenses, a few general terms should be understood; first of all, the focal length. If you hold any lens in sunlight and over a piece of paper, you will find that at a certain distance from the paper, the lens projects a sharp image of the sun. The distance from lens to paper is the focal length of the lens. If you are checking a thick lens like the compound type shown in Fig. 2, the focal length should be measured from paper to about halfway between the two lenses. This is not exactly accurate, but is close enough for practical use. Lenses recommended for projectors run about 4½ to 10-in. focal length. The f: value of any lens indicates the ratio between the focal length and lens diameter, and is found by dividing the focal length by the diameter. For example, a lens of 12-in. focal length and 1-in. diameter is rated f:12. If you take a piece of cardboard with a ½-in. hole in it and place it over the same lens, the f: value then is 12 divided by ½ or f:24. It can be seen that the higher the f: number the less light the lens will pass. Such lenses are called "slow." Lenses recommended for projectors should have an f: value of 11 or faster because good illumination is important.

Lenses: Lenses are described graphically in Fig. 2. From a study of this table, you



⑥ *Use this table to find*

1. GENERAL DIMENSIONS OF BOX—as determined by distance from lens to copy and size of copy covered.
2. WORKING SPACE NEEDED—as determined by distance from lens to image.
3. THE SIZE OF COPY any lens will cover at any specified degree of enlargement.

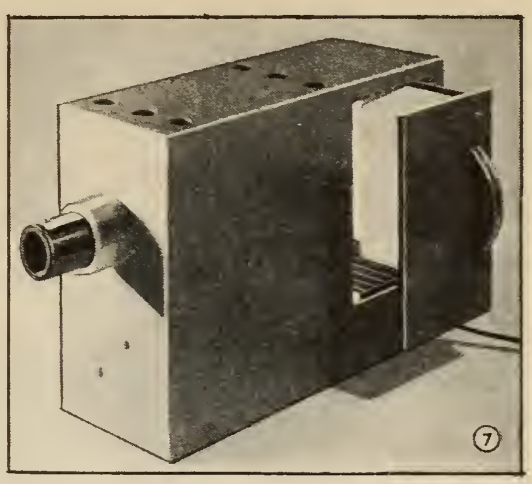
LENS	CHARACTERISTICS	DEGREE OF ENLARGEMENT — All dimensions are in inches								
		1X	2X	3X	4X	5X	6X	7X	8X	10X
3" FOCAL LENGTH	TO IMAGE	6	9	12	15	18	21	24	27	33
	TO COPY	6	4½	4	3¾	3⅜	3½	3⅜	3⅜	3⅜
	20° FIELD	2⅛	1⅝	1⅜	1⅜	1⅜	1¼	1¼	1⅜	1⅛
	25° FIELD	2⅜	2	1¾	1⅜	1⅜	1⅜	1½	1½	1½
	50° FIELD	5¼	4	3½	3¼	3¼	3⅛	3	3	3
3½" FOCAL LENGTH	TO IMAGE	7	10½	14	17½	21	24½	28	31½	38½
	TO COPY	7	5¼	4⅛	4⅜	4⅜	4⅛	4	3⅞	3⅞
	20° FIELD	2½	1⅞	1⅝	1⅜	1½	1⅜	1⅜	1⅜	1⅜
	25° FIELD	3⅛	2⅜	2⅛	1⅝	1⅞	1⅝	1¾	1¾	1¾
	50° FIELD	6¼	4⅝	4⅛	3⅞	3¾	3⅝	3½	3½	3½
4" FOCAL LENGTH	TO IMAGE	8	12	16	20	24	28	32	36	44
	TO COPY	8	6	5⅓	5	4⅞	4⅛	4⅜	4½	4⅜
	20° FIELD	2⅛	2¼	1⅞	1⅞	1⅞	1⅜	1⅜	1⅜	1⅜
	25° FIELD	3½	2⅜	2⅜	2¼	2⅛	2⅛	2	2	1⅝
	50° FIELD	7	5⅜	4¾	4½	4¼	4⅛	4	4	3⅞
4½" FOCAL LENGTH	TO IMAGE	9	13½	18	22½	27	31½	36	40½	49½
	TO COPY	9	6¼	6	5⅝	5⅜	5¼	5⅛	5	4⅝
	20° FIELD	3⅜	2⅜	2⅛	2	1⅝	1⅞	1⅞	1⅞	1¾
	25° FIELD	4	3	2⅛	2½	2⅜	2⅜	2¼	2¼	2⅜
	50° FIELD	8	6	5⅜	5	4¾	4⅜	4⅛	4½	4⅜
5" FOCAL LENGTH	TO IMAGE	10	15	20	25	30	35	40	45	55
	TO COPY	10	7½	6⅔	6¼	6	5⅓	5¾	5⅝	5½
	20° FIELD	3⅓	2⅝	2⅜	2⅜	2⅛	2⅛	2⅛	2	1⅝
	25° FIELD	4⅞	3⅝	2⅝	2⅜	2⅜	2⅜	2½	2⅛	2⅛
	50° FIELD	8⅞	6⅜	5⅞	5½	5⅛	5⅛	5	5	4⅞
5½" FOCAL LENGTH	TO IMAGE	11	16½	22	27½	33	38½	44	49½	60½
	TO COPY	11	8¼	7⅜	6⅞	6⅝	6⅛	6⅛	6⅛	6⅛
	20° FIELD	3⅞	2⅞	2⅜	2⅜	2⅜	2¼	2⅜	2⅜	2⅛
	25° FIELD	4⅞	3⅜	3¼	3	2⅞	2⅞	2¾	2¾	2⅛
	50° FIELD	9¾	7¼	6½	6	5⅞	5¾	5½	5½	5⅜
6" FOCAL LENGTH	TO IMAGE	12	18	24	30	36	42	48	54	66
	TO COPY	12	9	8	7½	7⅓	7	6⅞	6¾	6⅔
	20° FIELD	4¼	3⅜	2⅞	2⅝	2⅜	2⅛	2⅞	2⅝	2⅝
	25° FIELD	5⅝	4	3½	3⅜	3⅜	3⅜	3	3	2⅝
	50° FIELD	10⅝	8	7	6⅞	6⅜	6¼	6	6	5⅞
7" FOCAL LENGTH	TO IMAGE	14	21	28	35	42	49	56	63	77
	TO COPY	14	10½	9⅓	8¾	8⅓	8⅜	8	7⅞	7¾
	20° FIELD	4⅞	3¾	3⅜	3⅛	3	2⅞	2⅞	2⅞	2¾
	25° FIELD	6⅜	4⅝	4⅛	3⅞	3¾	3⅝	3½	3½	3⅜
	50° FIELD	12⅜	9¼	8¼	7¾	7½	7¼	7	7	6⅞
8" FOCAL LENGTH	TO IMAGE	16	24	32	40	48	56	64	72	88
	TO COPY	16	12	10⅔	10	9⅝	9⅝	9⅛	9	8⅛
	20° FIELD	5⅜	4¼	3¾	3⅞	3⅞	3⅝	3¼	3⅜	3⅛
	25° FIELD	7⅛	5⅝	4¾	4⅞	4¼	4⅛	4	4	3⅞
	50° FIELD	14⅛	10⅝	9½	8⅞	8½	8¼	8	8	7¾

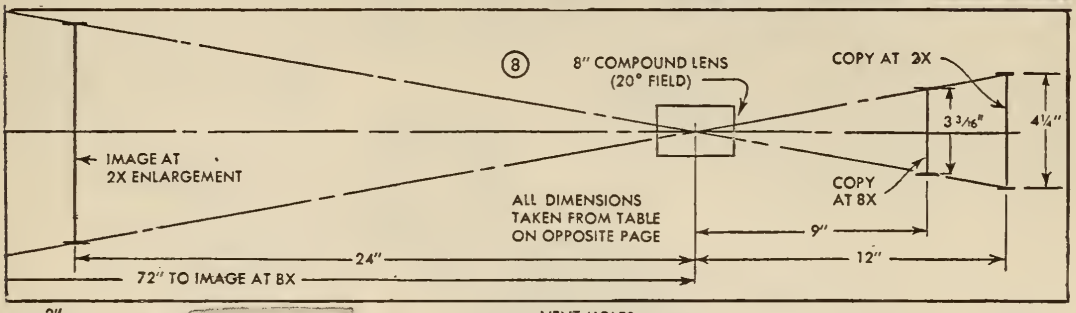
will note that the compound lens is the best lens for an inexpensive projector. Camera lenses are best if you want a large field, but the cost of a modern camera lens of suitable focal length is too high to make it practical for projector use. An earlier type of camera lens, the rapid rectilinear, or R. R., makes an excellent projector lens and usually can be located in second-hand photo stores. The projector lens is really an old-type portrait lens; in fact, one of the very first camera lenses. It is used extensively on movie projectors and gives excellent illumination because it can be worked at f:4. However, the field covered is small, and it is little better than the homemade compound lens, while costing much more. The compound lens is homemade from two plano-convex lenses which you can purchase for a few cents from any dealer handling chipped-edge lenses. It gives good definition over a 20-degree field when stopped down to about f:8.

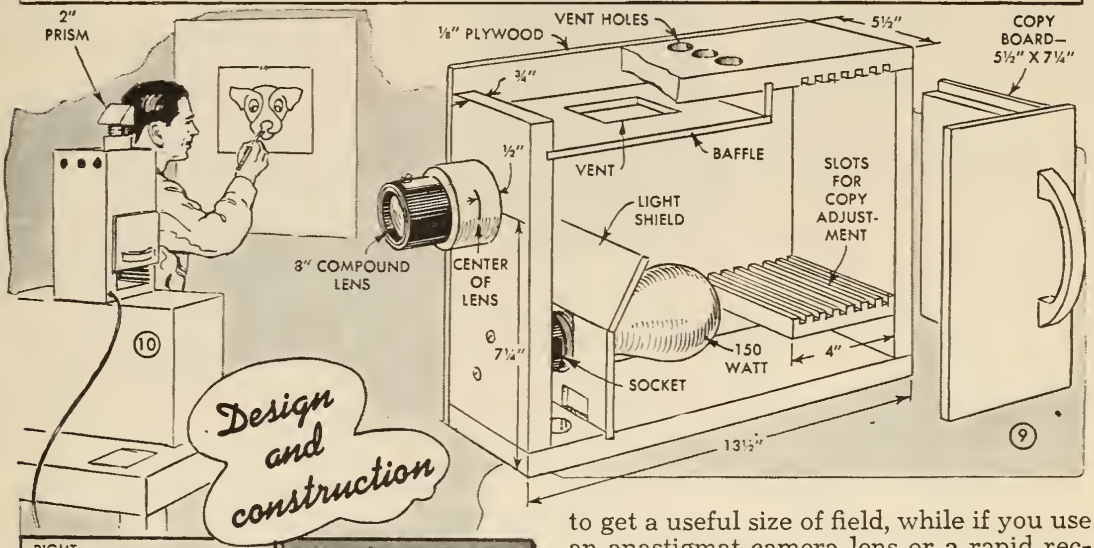
Making the compound lens: The compound lens in a slide-type mount is detailed in Fig. 5. Cylinders can be plastic or wood. The lenses should be about 1½-in. diameter by 15-in. focal length. The calculation for figuring the equivalent focal length of the combined lenses is given in Figs. 2 and 5. In this specific example, it works out at about 8 in. In order to favor the narrow field, the focal length should not be shorter than 7 in. Any lens of this type will give the best definition, or sharpness of image, if it is stopped down to about f:8 or f:11. To find the size of stop for any focal-length lens, divide the focal length by the desired f: number. In the example shown, Fig. 5, the focal length is 8 in., so the stop diameter would be 1 in. for a value of f:8.

Lens table: The lens table, Fig. 6, gives

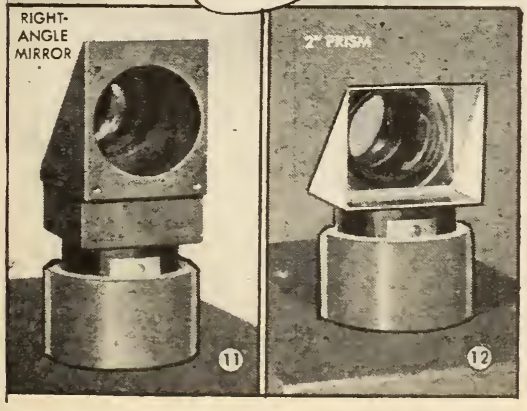
all the data you need in designing a projector for any particular lens or for any particular purpose. You will note that a long focal-length lens coupled with high magnification means a long throw from projector to screen, while a short focal-length lens means a short system. Also note that, for any specific lens, the longer the focal length the wider the field or size of copy you can cover. You will find that lens selection is a matter of compromise. You probably will want a fairly short system, possible with a short-focus lens, but at the same time you will want the large field obtained with a long-focus lens. If you use a single, compound or projector lens, you will have to go to at least 7 or 8-in. focal length





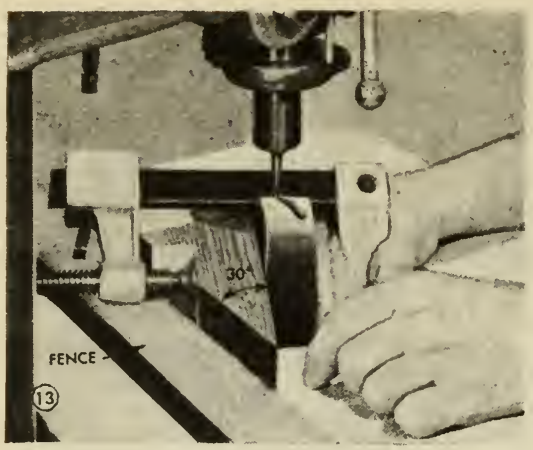


Design and construction



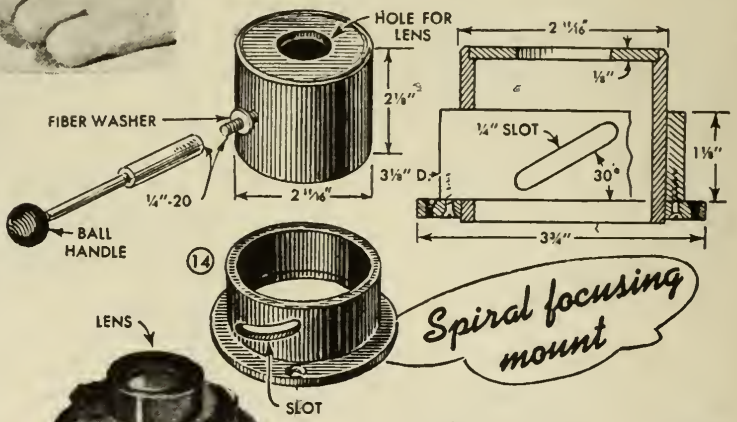
to get a useful size of field, while if you use an anastigmat camera lens or a rapid rectilinear, you can get a good-size field with a 4 to 6-in. focus lens. If you want data on focal lengths not shown in Fig. 6, simply double up; that is, figures for a 10-in. focal-length lens are double the figures for a 5-in. lens, and so on.

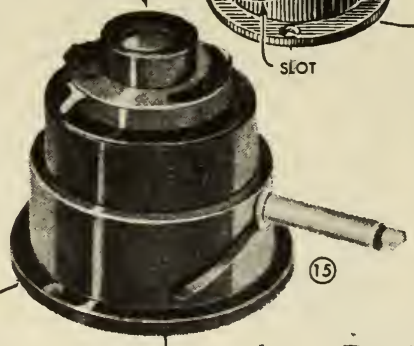
Designing a simple projector: Fig. 8 shows how the 8-in. compound lens previously described works out for a projector enlarging from 2 to 8 diameters. At 8X the copy will be 9 in. from the lens, while at 2X the copy will be 12 in. from the lens. These figures are taken from the table, Fig. 6. Also from Fig. 6, note that at 8X the



distance from lens to image will be 72 in. The total length of the system would be 84 in. when working at 8X. Obviously, a system this long could not be worked vertically because the average room height would not accommodate it. However, it would make a satisfactory horizontal projector. Made up as such, the construction might be something like Figs. 7 and 9, although the box can be any of a dozen shapes as long as it incorporates the optical distances needed.

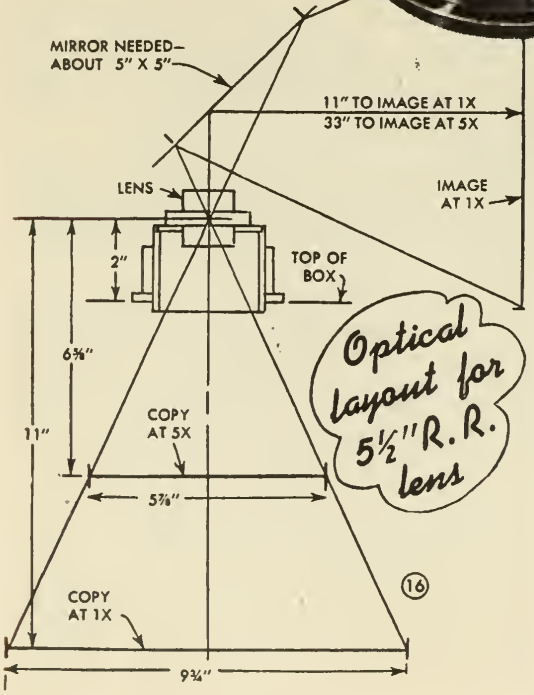
Erecting the image: A projector made as in Fig. 9 reverses the copy. This is not important for cutout work, but if you are working with lettering an erect image is needed. Erecting the image can be accomplished with a right-angle mirror, Fig. 11, or a 2-in. prism, Fig. 12. Both of these items can be purchased for about one dollar each from dealers handling surplus optical goods. When used with a mirror or prism, the box is mounted with the lens pointing toward the ceiling, as shown in Fig. 10.





The mirror or prism then will direct the image horizontally.

Spiral focusing mount: A good type of mount for the compound lens or for any camera lens is the spiral focusing mount shown in Figs. 14 and 15. Cylinders can be of wood or plastic. Fig. 13 shows how the slot is routed in a drill press.



The erecting projector: The mirror for erecting the image can be mounted permanently as part of the projector. In designing a system of this kind, optical dimensions are taken from Fig. 6 as previously described. A typical layout showing a 5½-in. rapid rectilinear lens in a spiral focusing mount is shown in Fig. 16. The R. R. lens covers a field of about 50 degrees. At 5X the lens shown will cover copy 5⅞ in. square. Figs. 17, 18 and 19 show how the construction is worked out to accommodate the optical dimensions. Built as shown, the box is designed primarily for horizontal mounting, as indicated in Fig. 1, but it also can be mounted vertically, as shown in Fig. 4. However, if specifically for vertical projection, it would be better to have the copy slide in from the end of the box.

Building your own: Specific projector designs serve only to show the general construction. When you design your own, you must make the box to suit your lens and

the range of magnification you want. Repeating the process as already described, you first make an optical layout, taking dimensions from the table, Fig. 6. Over this layout you then draw the shape of the box which will accommodate the optical dimensions. If you use a permanent mirror, the field angle should be drawn in, as shown in Fig. 16, in order to determine the size of mirror needed. Almost any kind of wood will do for the box. If the projector is to be a more or less permanent affair, or if it is to be subjected to considerable hard use, a good quality of material should be used. A small box can be made almost wholly from ⅛-in. plywood, this thickness in 3-ply birch being about right for side panels, top, etc. Join the parts with

A two-light box with mirror

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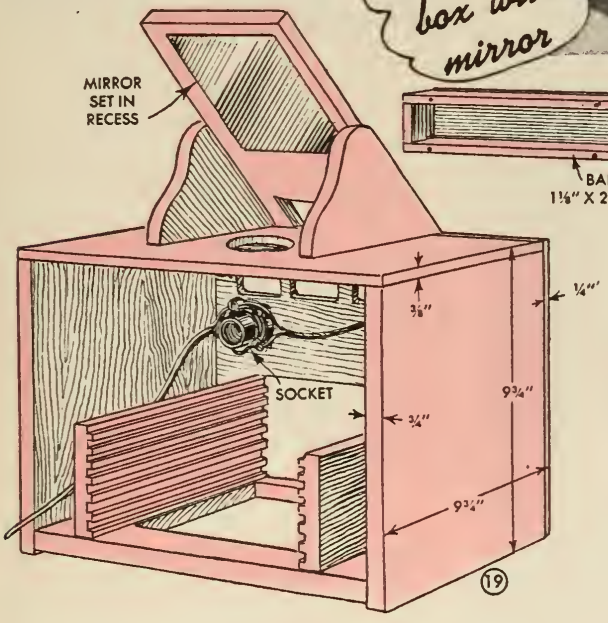

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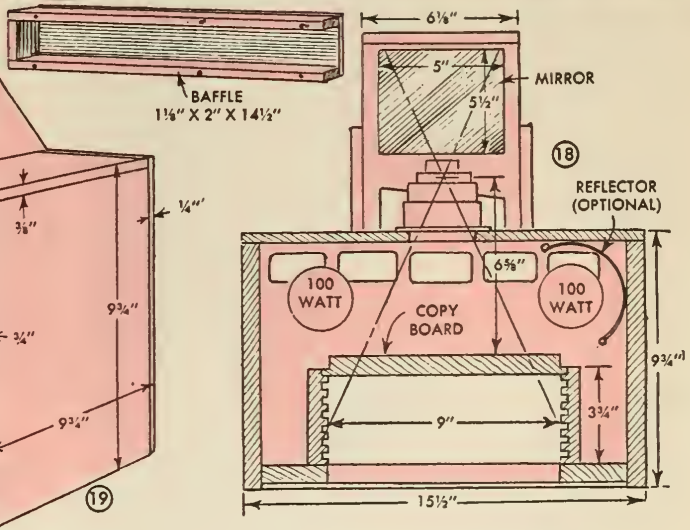

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small screws. There's no need to use glue in the joints. Where the copy board is tongued to slide in grooves, the grooves should be somewhat wider than the thickness of the tongue so that the board will slide in and out without sticking. The manner of making the light traps and baffles shown in Figs. 9 and 19 should be followed quite closely.

Limitations: Some limitations are worth noting: Lenses of less than 4-in. focal length should not be used because they require placing copy too close to the lens. Also, if anything but a camera lens, the field covered by a lens of less than 4-in. focal length will be too small. Lenses over 10-in. focal length should not be used because this places the image too far from the lens. The magnification limit of the simple compound lens is about 8X—over that, the image lacks sharp definition. With a camera lens or projector lens you can go as high as you like, but you will need strong lights to carry the image over the greater distance.

Finish: Paint the inside of the lens tube black. An ordinary oil paint should not be used in any case as heat from the lamps will cause cracking and peeling of the paint film.

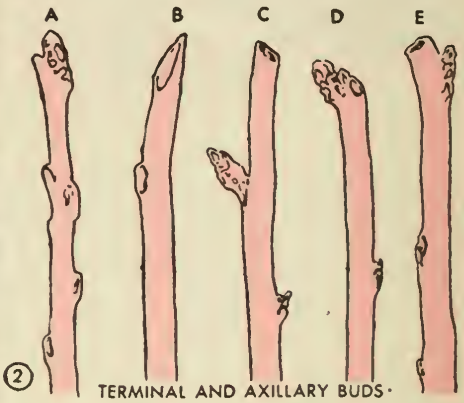
Good Pruning Aids Nature

By H. F. Roberts

PRUNING trees or shrubs is more than merely cutting off a few limbs or twigs here and there. Knowing what to take out and what to leave is the important thing, and this requires a careful study of each individual plant, taking into account its age, species and location. The time to prune varies with the locality. Some trees and shrubs can be pruned at almost any season while others will suffer extensive damage unless you do the job at precisely the right time. Experienced gardeners and orchardists say that dormant pruning is done best during January, February and March, but that the later it can be done during the dormant season the better, as the wounds will heal more quickly.

Except for formal treatment, the natural shape of the tree should be given every consideration. Each type has a typical form and pruning should emphasize this. The elm, for example, generally has a loose-growing vase shape; the Norway maple has a dense oval and almost formal one, and the pin oak has a pyramid shape with horizontal branching. Any tree will attempt to regain its normal form, regardless of trimming done to change it.

Most shade trees require relatively little pruning. Removal of dead, interfering and injured branches usually is all that is needed. All cuts should be made with a sharp saw as close to the crotch as possible

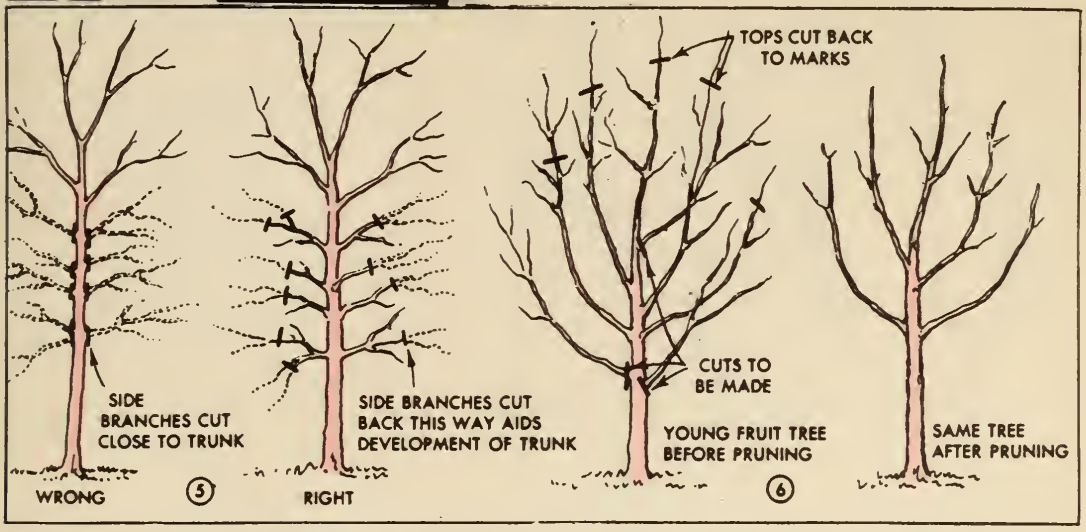


TERMINAL AND AXILLARY BUDS

④

bottom and the top, is to remove the stub. Very small branches are trimmed with a snap-cut pruner, Fig. 1. Any jagged edges should be shaved off, Fig. 4, and the wound painted thoroughly with tree paint, Fig. 7. Painting seals the cut and prevents moisture and decay from setting in before live wood covers the wound. Larger cuts should be painted each year because the cut portion may have a tendency to dry and crack. Some of the lower and inner branches of a tree usually die each year due to lack of sunshine. Also, some trees have a tendency to produce more branches than the roots can support and the weaker ones die off. These dead and dying branches should be removed regularly.

Frequently a tree will be found to possess a number of interfering branches which endanger the health of others by causing a crowded condition. Parallel branches too close together fall in this class also. Keep parallel branches at least a foot apart, and in removing interfering

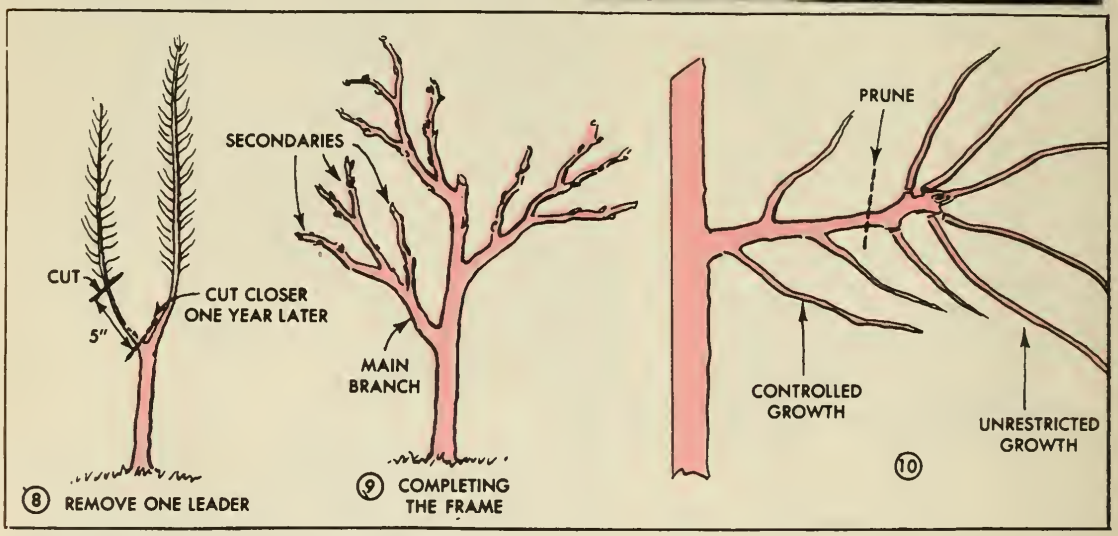


and parallel with the adjoining trunk or branch, Fig. 3. Leaving even a short stub will make proper healing of the cut difficult or impossible and may result in decay. Fig. 14 illustrates an incorrect cut where a stub has been left. Note that the live wood has been unable to cover the end and has receded, leaving a projection of dead wood which is ideal for decay. On smaller branches, the first cut should be made part way up from the bottom and then the second cut made from the top down, Fig. 13. If the cuts are not made in this manner, a tear that is very difficult to heal may result. Larger branches should be given even more care. A safe policy to follow is the one shown in Fig. 12. The first and second cuts are made as indicated to drop the limb, and the final cut, which is made from the branches, study the over-all arrangement to maintain good balance. Worn spots caused by rubbing branches are likely to develop decay which may, in time, spread to other portions. Rubbing is due frequently to crowded or parallel branches that are too close together. One should be removed to allow more freedom. Another point of interference is at a crotch. Fig 15 illustrates a poor crotch caused by three branches coming out at the same point, forming sharp angles. Removal of the middle branch allows room for the others to spread without crowding. When a branch is torn off by wind, ice or snow, a jagged wound often results. Such an area should be cleaned until only firm wood is left and then painted. This may require lengthening the gash considerably, but that is better than leaving rough,

frayed portions that will collect moisture. Paint for several consecutive seasons until the wound heals.

It's important to prune young trees because faulty branching can be corrected while the limbs are small. A good main crotching arrangement can be trained either high or low, depending on the tree's location. Street trees should be high so they will not interfere with traffic. Most lawn trees in city and suburban areas also should be "headed up" to permit circulation of air through the yard and to allow sunshine on the lawn. Where space is not at a premium, low trees add to the appearance of the yard. When training young trees, the side branches are sometimes completely removed up to the desired height, as in the left-hand detail of Fig. 5, which makes the trunk weak. The right-hand detail of Fig. 5 shows the same tree properly trimmed.

When pruning, the location of the cut in relation to the buds is important. Detail A



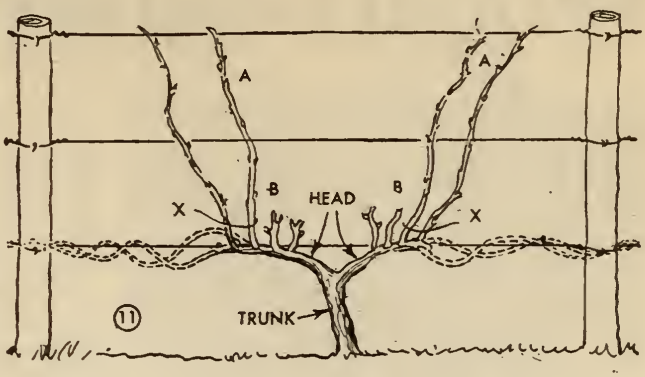
of Fig. 2 shows an unpruned branch. The terminal bud is at the tip with cluster buds at the base; farther down are axillary buds, which may be found in pairs. In detail B the cut is long and slanting, causing the wound to dry too slowly. Detail C shows a cut too far ahead of the bud and the stub may rot. The cut is too close to the bud in detail D and it may dry and drop off. The correct way is shown in detail E where the cut has a slight slant and is about ¼ in. above the bud.

If young trees have been planted, during the third year, or the second year if two-year trees were planted, shape the tree as in Fig. 9, treating each main branch as though it were an individual tree, except that the buds on it are not spaced around the branch, but should lie fanwise and parallel with the ground. Fig. 10 shows how growth is likely to develop if not cut back. This cutting forces the weaker buds below the cut to grow and form a well-knit frame. A newly planted tree, if it has developed two leaders, should have one cut, Fig. 8.

Fruit trees require a treatment slightly different from shade trees, although the method of pruning and the tools used, Fig. 16, are the same. Young fruit trees just being planted should be pruned to develop proper crotching and branching. The leader and three or four of the side branches should be retained. Both the leader and the remaining side branches should be cut back so the leader is 4 to 6 in. longer, left-hand detail of Fig. 6. The right-hand detail shows the same tree after pruning. When fruit trees begin to bear, their annual growth

generally lessens because of the strength required to develop fruit. As a rule-of-thumb, the need for pruning is limited usually to the removal of dead, interfering, diseased or damaged branches. There is one type of branch found on fruit trees that is not often encountered elsewhere. Sometimes this is called a "sucker" or "water" branch and will not bear fruit, but due to its rapid growth it will have a tendency to sap the strength from other branches. Most of these spring from the main branches and grow in an upright position. This type of growth should be removed.

Among the several systems used for pruning grape vines, the one illustrated in Fig. 11 is widely chosen because it is simple and produces renewal canes that are close to the head. During the latter part of each winter, but not when the vines are frozen, leave two or more long canes, AA, having five to ten buds each, and cut a similar number of canes, BB, back to spurs having one or two buds each. Then cut away all other growth. In effect, the long canes will produce shoots on which grow the following summer's crop, while the short canes become renewals that will bear the crop of the second summer. Early in spring, bring the long canes down and tie them as indicated by the dotted lines. Later reduce each short cane to a single strong shoot and tie to the upper supports. This process is repeated each season. When selecting renewals always select those as close to the head as possible. In many cases these may be coming from the trunk. The total number of buds that the long canes will carry depends upon the soil, vigor of the plant and similar factors. When well established, the popular Concord grapes can carry 50 to 60 buds to a vine, whereas less vigorous varieties should be held to a maximum of 25 to 30 buds to obtain the best yield. Like trimming trees, this type of work requires only a few simple tools. Lopping shears and a snap-cut pruner are all that are required in most cases.



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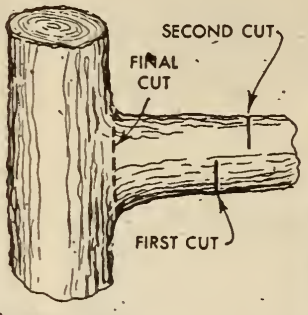
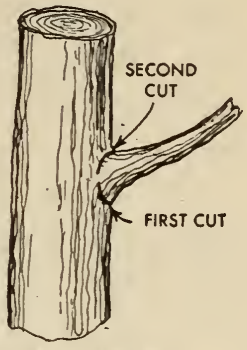
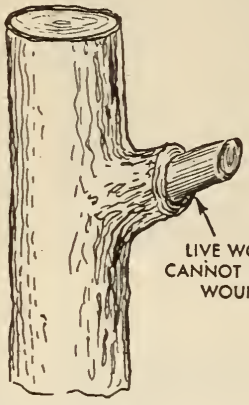


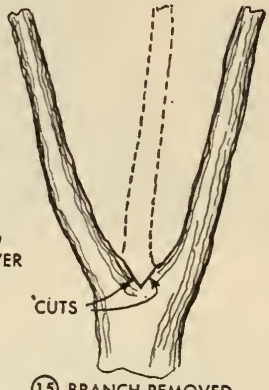
12 LARGE LIMBS



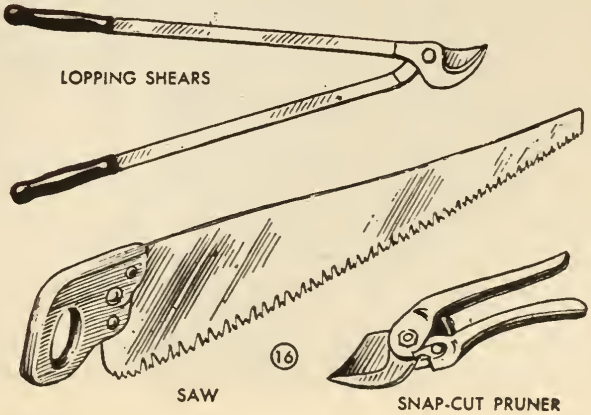
13 SMALL BRANCHES



14 WRONG WAY

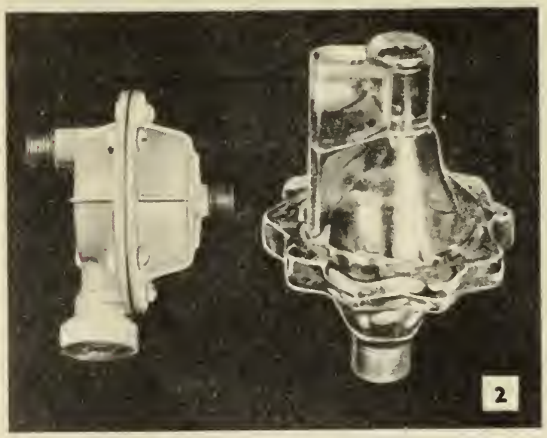


15 BRANCH REMOVED TO DEVELOP STRONG CROTCH



TROUBLE-SHOOTING HINTS

Above, testing continuity of circuit through pressure switch determines if that component is working. Shown below are two types of air-volume controls



Below, centrifugal governor is spring-loaded device at center, internal switch is V-shaped object above it. Cylinder is capacitor, overload switch is below

ALTHOUGH THE JET PUMP used in most home water systems is a reliable unit that will run for years with very little attention, it will pay the homeowner to know something about its operation. Then, when the pump stops running—inevitably this will be on a week end or at night when no service man can be reached—he can do something about restoring this service.

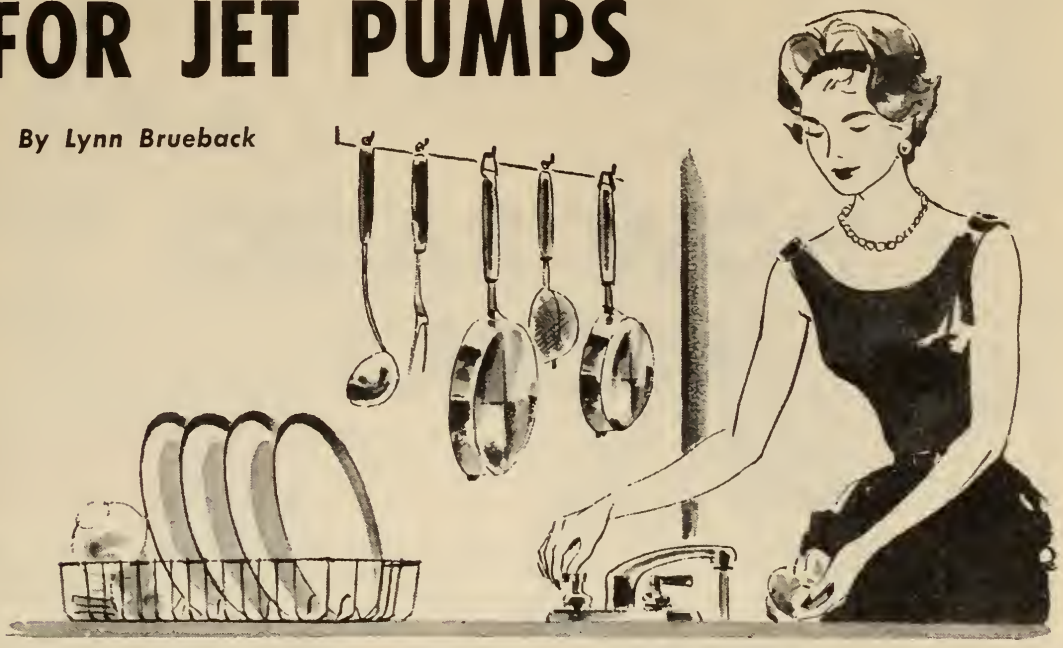
Basically, a jet pump, Fig. 4, is a centrifugal pump in which is included an orifice that discharges part of the water pumped by the impeller through a venturi. This action creates a vacuum, increasing the capacity of the pump. A shallow-well pump has the jet cast into the pump body, while a deep-well pump has the jet located outside the pump itself. If your pump will not shut off and produces only low pressure, check the jet. If it is clogged with scale or dirt it will not work properly. A centrifugal pump without a jet will produce only about 25 lb. of pressure. As the pressure shutoff switch on a jet pump is adjusted to start the pump at 20 lb. and shut it off at 40 lb., the low pressure simply will not actuate the switch.

If the pump motor does not run, first check the fuses and power supply. Next, remove the cover on the pressure switch, Fig. 1, and check for continuity of circuit. A neon-type test light, such as shown, is ideal for this. Now check the internal motor switch, which is located at the end of the motor housing, Fig. 3. This switch, one arm of which carries the numeral 5, works in conjunction with a centrifugal governor, its purpose being to change the motor from the start winding to the run winding at the proper speed. If the switch points are dirty, or if one of the springs is missing or broken, or if the switch is not adjusted properly against the governor, no current will flow. A capacitor and an overload switch also are located on this end of the motor. Check these by bypassing them with a jumper wire. Do not run the motor very long with no water in the pump. Most shaft seals are water-lubricated.

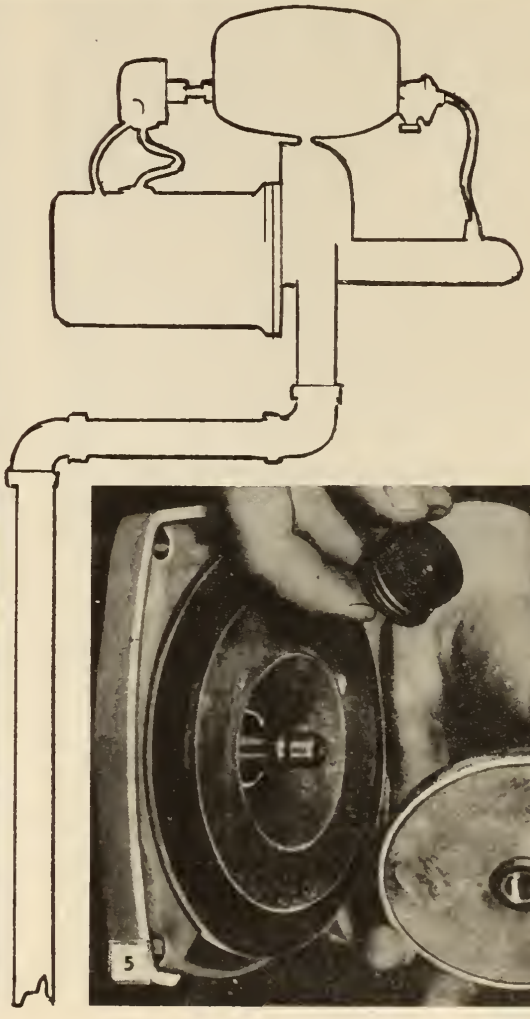
If a pump loses prime, or cannot be primed, check the foot valve, located at the lower end of the suction line. Whether gravity type or spring-loaded, this valve must close tightly when the pump is not running. If a pump loses prime while it is running, make sure the foot valve is submerged. A small-diameter drilled well may have too slow a recovery rate during dry spells to keep the valve submerged. If a

FOR JET PUMPS

By Lynn Brueback



pump runs even when no water is being drawn, it is due to a leak in the pressure side of the system. Check all connections and the pump seal, Fig. 5. Water-logging of a pump can be traced to a faulty air-volume control, Fig. 2, or to continuous running for long periods. Most air-volume controls draw in air only when the pump is not running. The water-volume control is also adjustable, being located between the pump and tank on the pressure side. For adjusting this, use a vacuum gauge, connected to the pump at the air-volume control. Start the pump and adjust the water-volume control until the gauge reads about 22 in. of vacuum at sea level. ★★★



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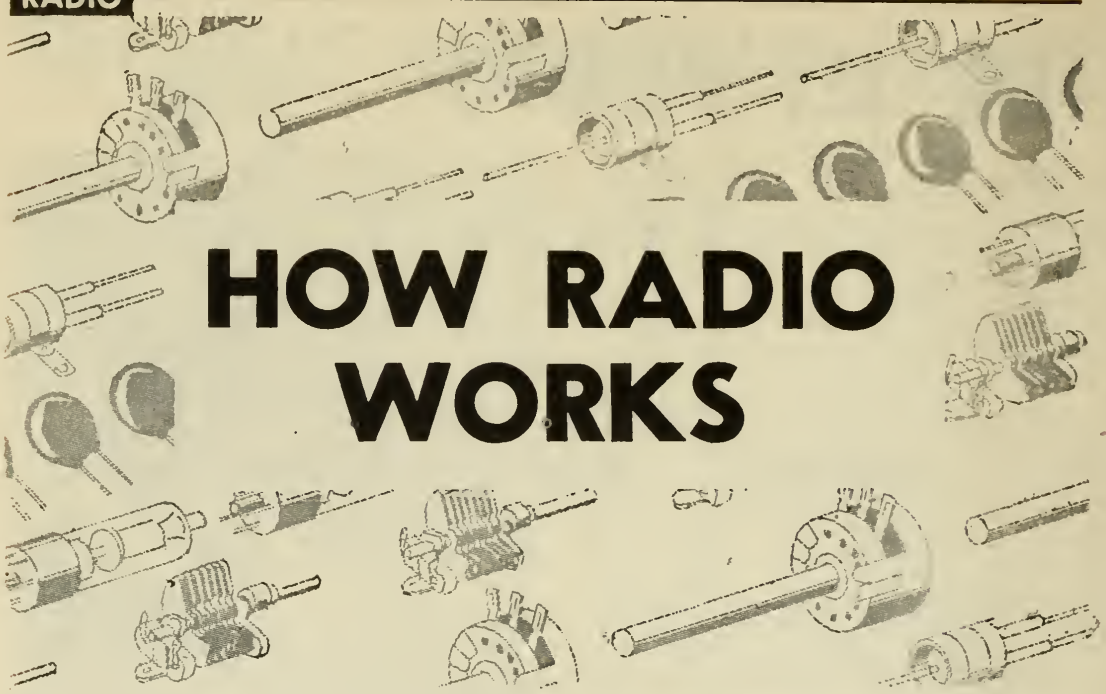


HOW RADIO WORKS

IF YOU HAVE EVER marveled at the "magic" of radio or the "mysteries" of electronics, you may be in for a surprise. For there is no magic to radio, and electronics, stripped of its awe-inspiring name, emerges as a science whose principles, though fascinating, can readily be understood without a great deal of scientific training or knowledge.

The actual construction of radios and other electronic projects requires little more than the ability to handle a few basic tools and some care in following simple instructions. Therefore, if like most electronic beginners, you are anxious to start building your own equipment, you can. If you are curious as to the operation of radio, how those "mysterious" waves carry sound for hundreds of miles, it will pay you to first study the fundamentals.

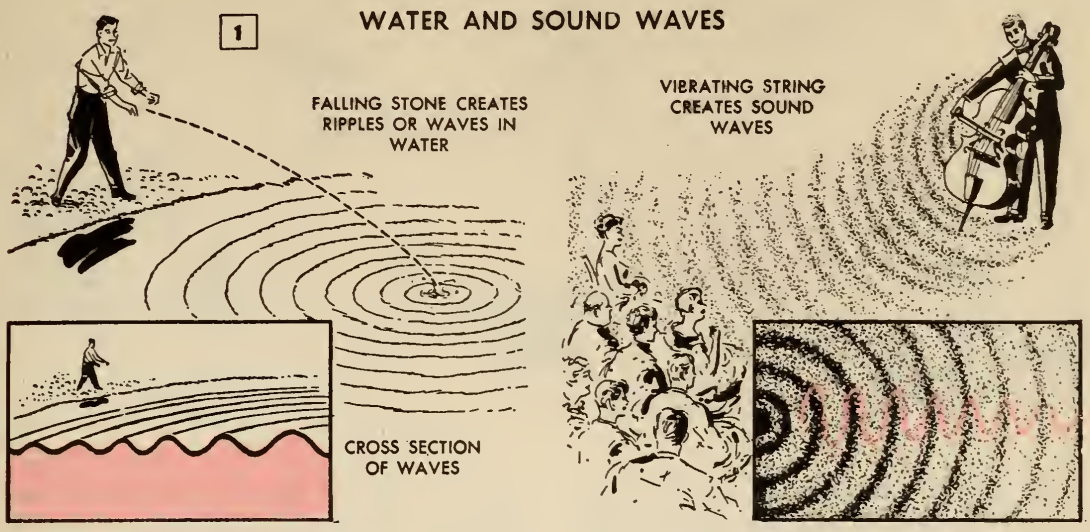
To understand the operation of radio we must first ask ourselves "What is the purpose of radio?" Then, we can investigate how this purpose is accomplished.

Simply stated, the function of radio is to permit a listener at one point to hear sound produced at another point. These stations or points may be hundreds of miles apart. Since this entire principle is based on the transmission and reception of sound, we must first determine the nature of sound and investigate some of its characteristics.

Sound travels in the form of waves. These waves are completely invisible and are difficult to visualize. However, since sound waves act very much like water waves we can use these in our explanation.

If you drop a stone into a pool of still water a number of ripples, or waves, are created in the surface, Fig. 1. These waves start at the point where the stone is dropped and travel outward in concentric circles of ever increasing diameters. This gives the appearance that the entire surface of the water is moving away from the point where the stone was dropped. But, if you drop a cork into the ripples you will note that the cork merely bobs up and down, and does not follow the outward movement of the waves. It is apparent, therefore, that the water does not move in an outward direction, but merely rises and falls above and below its natural level. While the actual body of water does not move, the ripples, or waves, set up by the disturbance do seem to move away from the place where the stone dropped.

Like water waves, sound waves are caused by a variation in pressure. If a guitar string is plucked, it will vibrate back and forth very rapidly. The string, in its forward movement, pushes the air before it and compresses the air molecules. At the same time, air rushes in to fill the space behind the moving string, so that the air

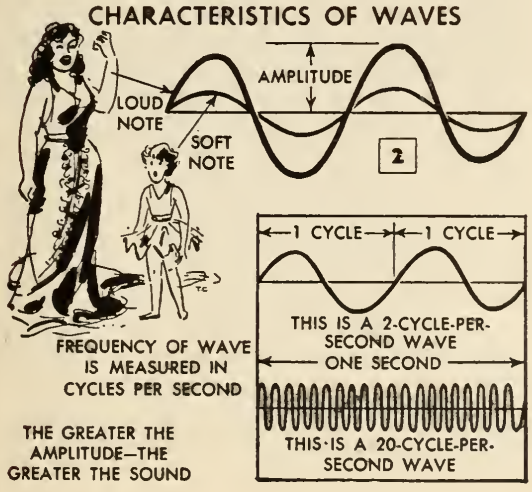


String, reed or vocal-cord vibrations set up air waves which, like water waves, spread out in all directions

behind the string is expanded. While the air itself moves only a small distance, corresponding to the actual movement of the guitar string, the pressure created by this movement travels in the form of air waves over a relatively long distance. Eventually, however, the waves are completely absorbed by the atmosphere.

When the variations in air pressure reach our ears, they set up similar vibrations in a very thin membrane within the ear, called the ear drum. This gives us the sensation of sound. In general, our ears are sensitive to vibrations which occur at a rate of from 20 to 20,000 times a second. We do not hear vibrations above or below these limits.

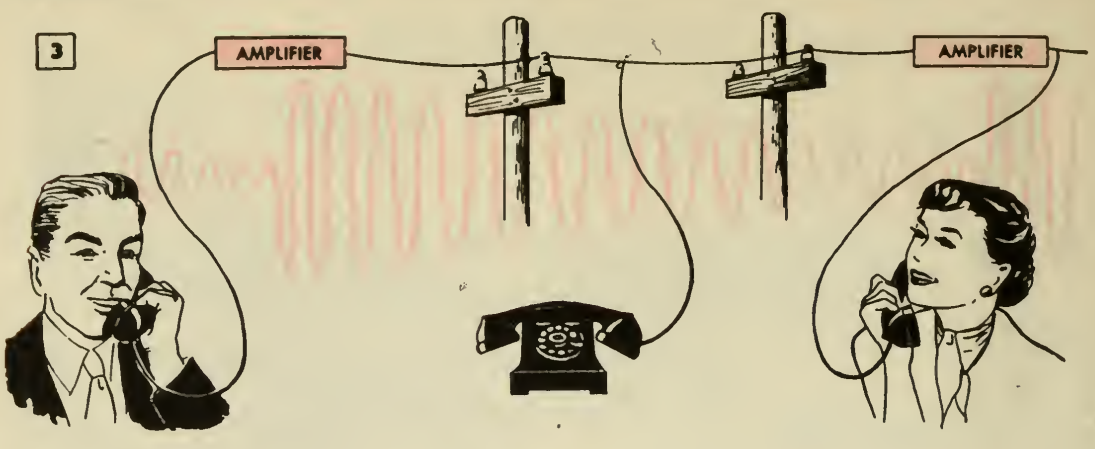
The number of variations in air pressure which occur in a given period of time is called the *frequency* of the wave, while the variation from the normal pressure to the maximum peak is called the *amplitude,* Fig. 2. The frequency, which is measured in cycles per second, determines the pitch of the corresponding tone, while the amplitude determines its loudness. A wave with a very low frequency will sound like a low rumble while a high-frequency wave will sound like a high-pitched whistle. The frequencies between these two extremes give us all the sounds in the tonal register.



Sound waves travel at a speed of about 1100 ft. per second, but since they are easily absorbed in the air, they can be heard for only a short distance. However, these waves are easily converted into electrical-current waves which can travel for hundreds of miles. The device for converting sound into electrical waves is a microphone.

Electrical currents, which are more fully explained later in this section, can be carried by wire cables over long distances. Furthermore, before these currents are completely absorbed by the *resistance* of the cable, they can be reamplified, so that they can be transmitted as far as desired. At any point along the cable, the current waves can be reconverted into sound waves by means of earphones or loudspeakers. Such a system is used to provide world-wide telephone communication, Fig. 3.

While wired communication is entirely practical, it has several disadvantages. One of these is the fact that the listener must be stationed at a particular place along the



cable where a listening post is set up in order to receive the transmissions. Furthermore, such a system is relatively expensive since it involves the installation of long cables and an elaborate system of amplifiers. Obviously, there remains a need for a method of long-distance communication which is not limited by wires or cables. This has brought about the invention of wireless communication, or radio.

The radio signal

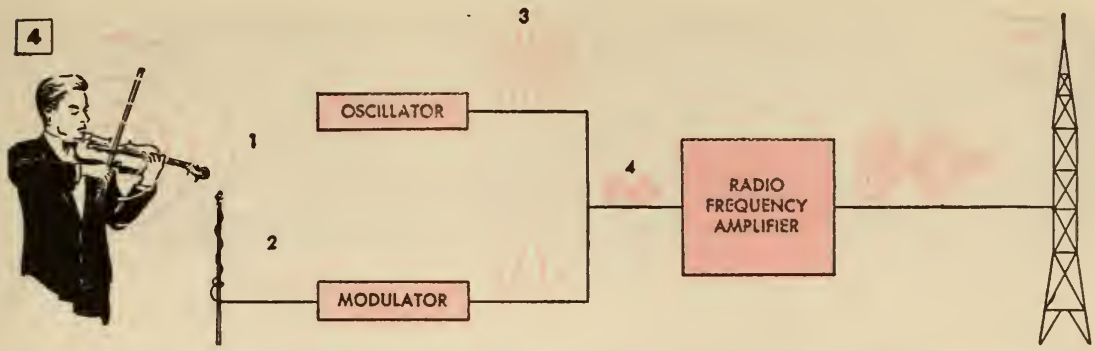
Just as sound waves can be converted into current waves by means of a microphone, some current-waves can be transformed into electromagnetic waves by means of an antenna. These do not depend upon air or wires as a transmitting medium, but, like sound waves, they travel in all directions from the point of origin.

Since electromagnetic waves, or radio waves, as they are generally called, travel through space without actually depending on air as a medium of transmission (they can travel equally well through a vacuum) their absorption by the atmosphere is small. As a result, such waves can travel over long distances before they become too weak to be received. They are therefore ideally suited for long-distance communications.

Radio waves, in order to be efficiently transmitted into space, must have a very high frequency. This means that they must alternate about 100,000 times, or more, per second in order to carry for any long distance. As mentioned previously, the highest frequency which can be heard by the human ear is about 20,000 cycles per second. Therefore, even if these high-frequency radio waves could be converted into equivalent sound waves, they could not possibly activate our ear drums. On the other hand, those frequencies which are audible can not be transmitted over any great distance. Therefore, to make possible the transmission of radio broadcasts, the current waves corresponding to the sound are impressed upon high-frequency radio waves, so that both will be transmitted simultaneously. The radio waves thereby provide a means for carrying the audio information from the transmitting antenna to the various receiving sets.

The principles of a complete broadcasting and receiving system are illustrated in Fig. 4. The sound waves (1), caused by a vibrating violin string are changed by a microphone into equivalent electrical current-waves (2). These current-waves are amplified and sent to a modulator. In the meantime, an oscillator (which acts as a radio-wave generator) in the transmitter is producing a constant flow of high radio-frequency current-waves (3), which will act as carrier waves. These carrier waves are then combined with the converted sound waves from the modulator to form a modulated wave. Next, the modulated wave (4) enters the radio-frequency amplifier where it is increased in strength.

The modulated wave still has the basic frequency of the carrier, but it is no longer constant in amplitude. As a matter of fact, both the top and bottom of the wave vary in exact accordance with the audio wave with which it has been combined. When this wave is applied to the antenna, it is converted into corresponding radio waves which are radiated into space. If such a radio wave passes a receiving antenna, the antenna extracts a small portion of its energy and reconverts this into current-waves



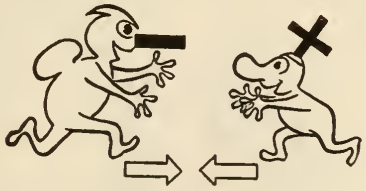
Sound waves are combined in the transmitter with high-frequency radio waves and transmitted into space

of the same frequency. These current-waves are then applied to a detector which cuts off the bottom (or top) half of the wave (5). To complete the reconversion, a filter circuit eliminates the high-frequency variations, leaving only the modulating envelope (6), which corresponds to the original audio wave. These audio current-waves are then changed into sound waves by means of a loudspeaker.

Of course, a typical receiver includes a number of amplifiers which are not shown in this simple diagram. These amplifiers merely serve to increase the amplitude of the waves so that they will have sufficient power to drive the loudspeaker.

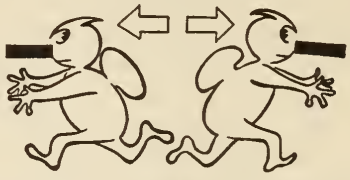
The electron theory

The entire operation of radio is made possible by the movement of tiny electrical particles called electrons. These particles are too small to be seen even under the most powerful microscope, yet they are present in all types of matter, be it solid, liquid or gas. Electrons carry a small negative charge of electricity and, together with their positively charged brothers, the protons, they form an atom.



Oppositely charged particles will attract each other

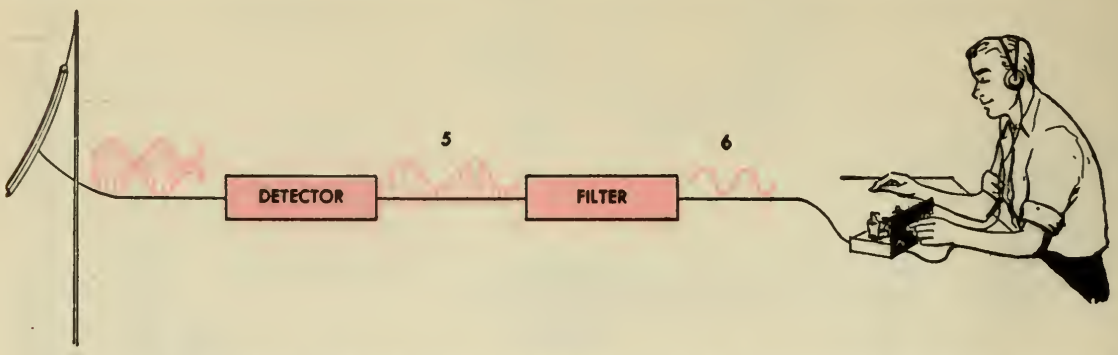
An atom is made up of a nucleus consisting of a cluster of electrons and protons plus a number of free electrons. These free electrons move in circular paths around the nucleus. Altogether, an atom must contain exactly as many electrons as it does protons. Therefore, if there are two electrons circling around the nucleus, there are two extra protons within the nucleus. These extra protons apply a controlling force on the electrons in the outer rings and prevent them from flying off into space. It can be stated that two oppositely charged particles, such as protons and electrons will attract one another, while two similarly charged particles, such as two electrons or two protons, will repel each other.



Similarly charged particles will repel each other

Although all atoms consist of electrons and protons, different atoms vary in the number of such charged particles they contain. The difference between a helium and lithium atom, for example, is shown in Fig. 5. The structure of a particular atom determines the type of element which will result when billions of these are combined.

In some atoms, the free electrons of the outer rings are very strongly attracted to their own nucleus, so that it would require an extremely strong force to pry even a single electron out of its orbit. Materials consisting primarily of such atoms are called insulators. In other atoms, the attracting force between the nucleus and the free electrons in the outer rings is quite small. So small, in fact, that its free electrons can easily be attracted to the nucleus



Radio waves are picked up by receiver and changed into audio waves. These are then reproduced by speaker

of some other atoms which may happen to be in the vicinity. Materials composed primarily of such atoms are called conductors. In conductors there is a continuous exchange of electrons between the various atoms.

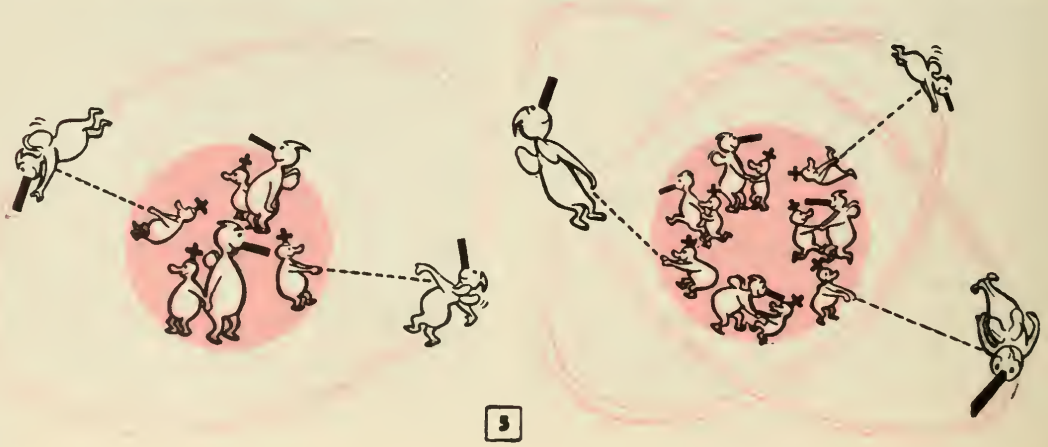
Electron movement

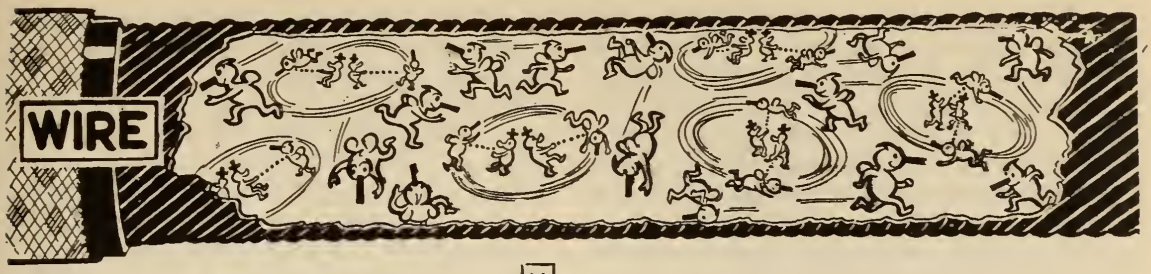
The movement of electrons from one atom to another constitutes an electric current. In conductors, there are many currents flowing at all times. These minute currents flow in various directions and at random intervals, Fig. 6A. They are too small to do any useful work. However, if some external force is applied requiring all of the free electrons to move from atom to atom in the same direction, Fig. 6B, the resultant current flow can become quite large and can be harnessed to accomplish some specific purpose. For example, when billions of electrons are forced to flow through a piece of wire, the wire will become very hot. This principle is used to provide us with many of our electrical appliances such as irons, coffee makers, toasters, etc.

Voltage

The force which causes the free electrons in a conductor to move in the same direction is called voltage. One of several voltage-producing devices is a battery. A battery can consist of two dissimilar metal plates (one plate being made of copper, the other one of zinc) which are emersed in a chemical solution such as hydrochloric acid. When this acid makes contact with

The structure of simple atoms. Helium atom is shown at the left. Lithium atom is illustrated at the right





6A

the metal plates, a strange reaction takes place. The acid literally tears the zinc atoms out of the zinc plate. These atoms, however, are reluctant to leave and, consequently, some of their electrons remain behind. As a result, the zinc plate soon has a large number of excess electrons and attains a negative charge.

While this is going on, the acid also goes to work on the copper plate and removes the *electrons* from the copper atoms. The copper plate, therefore, has an excess of protons which leaves it with a positive charge. Now, we know that the positive protons of the copper plate will attract the negative electrons of the zinc plate, but there is no way the electrons can reach the protons. As a result, a definite tension, or voltage, exists between the two plates.

When a conductor, such as a piece of wire, is connected between the two plates, a path is created for the electrons in the zinc plate to reach the protons in the copper plate. The electrons will rush into the wire only to collide with some of the atoms in the wire. In doing so, they will knock off some of the free electrons of these atoms. These free electrons are also attracted to the copper plate and in travelling towards the plate, they knock off the free electrons of other atoms. These electrons all travel towards the positive plate causing a large current flow in the wire.

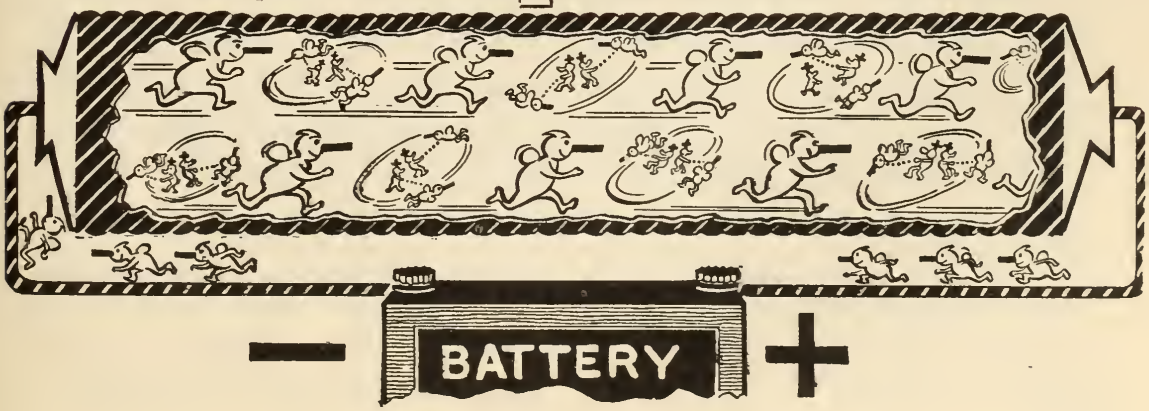
Electrical pressure, or tension, is measured in volts. The current which flows when a voltage is applied to a conductor is measured in amperes. An ampere of current is equivalent to billions of electrons flowing past a given point in one second.

Since the current flowing through the wire in the previously mentioned example always moves in the same direction (from the negative to the positive battery terminal), it is called a direct current. The voltage producing this current is called a d.c. voltage. If the position of the battery were periodically reversed so that the current through the wire would flow first in one direction and then the other, the current would be called alternating current. The voltage producing this is termed an a.c. voltage.

Resistance

As mentioned previously, the ease with which electrons can flow in a particular material depends upon the type of atoms the material contains. The more free electrons present, the larger the current which results when a voltage is applied.

6B



All materials, regardless of their composition, offer some opposition to the flow of current. This opposition is called resistance. However, since the nuclei of some atoms hold more tightly to their associated free electrons than others, some materials have more resistance than others. Insulators, such as rubber, glass and fiber, whose atoms refuse to release their free electrons, have a very high resistance and permit little or no current to flow, even if the applied voltage is high. Conductors, such as silver, copper or aluminum, as well as most other types of metals, offer very little resistance to the flow of current. In between these materials we have others which offer a varying amount of resistance, and these are used in electronic circuits to limit the current by any desired amount.

Resistance is measured in *ohms*. A material has one ohm of resistance if it permits one ampere of current to flow when one volt of pressure is applied. In radio work you will use resistors with values ranging from a few ohms to several million ohms (megohms). Such resistors usually are small cylindrical units made of carbon or a special wire called resistance wire. The value of the resistor is usually marked on the body of the unit by means of different colored stripes, each color representing a specific number. Instructions for interpreting this color code are given in the appendix of this book.

Direct-current theory

Early in the 19th century, George Simon Ohm, a German physicist, found that there is a definite relationship between the voltage, current and resistance in a circuit. This relationship, named after its discoverer, is called Ohm's law.

Ohm's law states that the current in a d.c. circuit is always equal to the applied voltage divided by the resistance in the circuit. From this simple statement we can write three mathematical formulas which tell the whole story. These are as follows: $I=E/R$; $E=I\times R$ and $R=E/I$. In these three formulas, I equals current in amperes, E equals voltage in volts and R equals resistance in ohms.

The use of these formulas can best be explained by a few examples:

Example 1: A flashlight bulb has a resistance of 10 ohms and the manufacturer states that it requires .15 amp. of current to light the bulb to full brilliance. How much voltage must be applied so that the bulb will light properly?

Solution: Since we want to find the amount of applied voltage, we will use the formula $E=I\times R$. *Therefore,* $E=.15\times 10=1.5$ *volts. Thus, a single flashlight cell will light the bulb satisfactorily.*

Example 2: A soldering iron is plugged into a 110-volt house outlet. A meter shows that 2 amperes of current flows through the iron. Now, what is the iron's resistance?

Solution: Since we want to find the resistance of the iron we will use the formula $R=E/I$. *Therefore,*

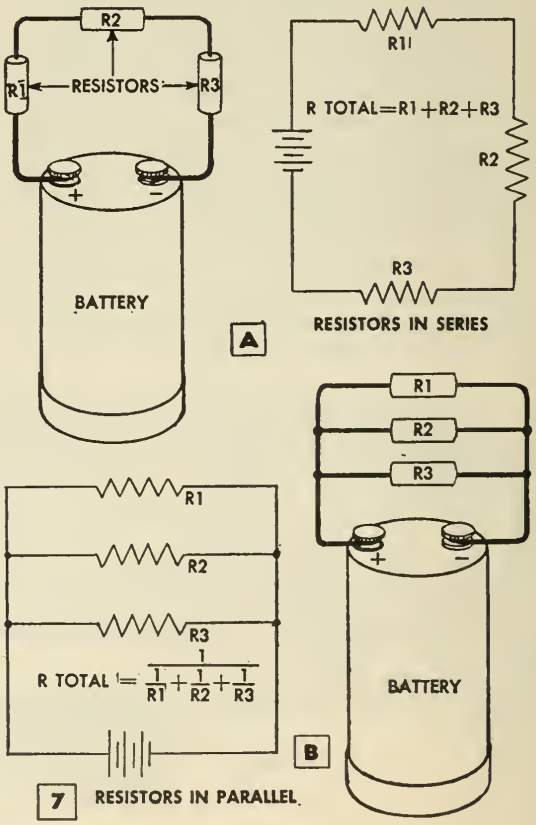
$$R=\frac{110 \text{ volts}}{2 \text{ amperes}}=55 \text{ ohms.}$$

Example 3: How much current will flow through a 100-ohm resistor if we apply 110 volts across the resistor?

$$\text{Solution: } I=\frac{E}{R}=\frac{110}{100}=1.1 \text{ amperes.}$$

Resistors in series

If two or more resistors are connected together as shown in Fig. 7A, they are said to be connected in "series." When resistors



are in series the total resistance is equal to the sum of the individual resistances.

Example: Three 10-ohm flashlight bulbs are connected in series. How much battery voltage must be applied if each bulb must receive .15 amperes of current?

Solution: When resistors are connected in series across a voltage source, the same current will flow through each of the resistors. Therefore, in order to find the amount of voltage required to cause a current of .15 amperes to flow in the entire circuit, we must first find the total resistance. Since the total resistance in the circuit is the sum of the individual resistances, we can solve the problem as follows:

Total resistance=

$$R_1+R_2+R_3=10+10+10=30$$

If the circuit resistance is 30 ohms, we can find the voltage needed to cause a .15 ampere of current to flow by the formula $E=I\times R=.15\times 30=4.5$ volts. Therefore, a 4½-volt battery is required.

To illustrate a practical example of a simple series connection, let us assume that you have a light bulb rated at 110 volts, and 1 ampere. The resistance of the bulb is

$$R=\frac{E}{I}=\frac{110}{1}=110 \text{ ohms.}$$

Now let us assume that the line voltage in your area is 220 volts rather than the standard 110 volts. If you were to connect the bulb across this excessively high voltage a total current of

$$I=\frac{E}{R}=\frac{220}{110}=2 \text{ amperes}$$

would flow through the bulb. This would cause the filament of the bulb to burn out. But if you were to connect two identical bulbs in series, the total resistance of the circuit would increase to R1+R2=110+110=220 ohms. The total current flow through the circuit is then

$$\frac{220 \text{ volts}}{220 \text{ ohms}}=1 \text{ ampere.}$$

This is the correct amount for each bulb.

The total applied voltage actually divides itself between the two bulbs, half of it, or 110 volts, being used up in forcing the one ampere of current through the first bulb, while the remaining 110 volts is forcing the current through the second one. The second bulb could be replaced with a 110-ohm resistor with the same results.

Resistors in parallel

Resistors are said to be in parallel when they are connected as shown in Fig. 7B. If resistors are connected in parallel across a battery, the entire battery voltage will be applied to each individual resistor. The current through one resistor need not necessarily be equal to the current through any other, since each individual current is governed only by the value of the resistor and the applied voltage. The total battery current is equal to the sum of the currents through the individual resistors.

The total resistance value of a parallel circuit can be calculated by the formula,

$$R \text{ total}=\frac{1}{\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}}$$

This is always less than the value of the smallest individual resistance.

Example: Three resistors are connected in parallel across a 9-volt battery. The resistance values are 3, 6 and 9 ohms respectively. Find "R total," the current through each resistor and the total battery current.

Solution:

$$R \text{ total}=\frac{1}{\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}}=\frac{1}{\frac{1}{3}+\frac{1}{6}+\frac{1}{9}}$$

Finding the lowest common denominator in the above equation we have:

$$R \text{ total}=\frac{1}{\frac{6}{18}+\frac{3}{18}+\frac{2}{18}}=\frac{1}{\frac{11}{18}}=\frac{18}{11} \text{ ohms}$$

$$I \text{ total}=\frac{E}{R \text{ total}}=\frac{9}{\frac{18}{11}}=\frac{9\times 11}{18}=5\tfrac{1}{2} \text{ amperes}$$

Since each resistor is individually connected across the battery, the current through each can be found by $I=E/R$. Therefore,

$$I_{R_1}=\frac{9}{3}=3 \text{ amperes}$$

$$I_{R_2}=\frac{9}{6}=1\tfrac{1}{2} \text{ amperes}$$

$$I_{R_3}=\frac{9}{9}=1 \text{ ampere}$$

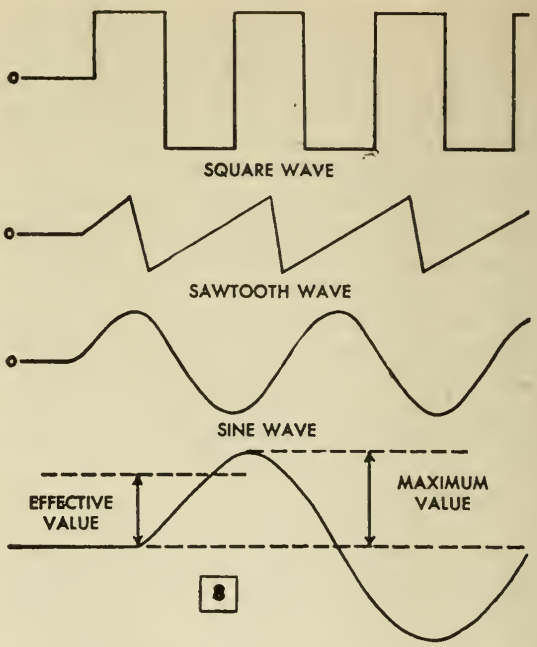
The total battery current is the sum of the individual currents $3+1\frac{1}{2}+1=5\frac{1}{2}$ amperes. This total current value is the same as previously calculated by the formula

$$I \text{ total}=\frac{E}{R \text{ total}}$$

Alternating-current theory

We have already learned that there are, basically, two types of current: a direct current and an alternating current. Alternating currents can be produced by many different types of a.c. generators, such as microphones, oscillators and others.

There are many types of a.c. currents, some of which are illustrated in Fig. 8. These are generally called "waves," their exact names depending on the shape of each particular "wave."



All alternating-current waves periodically reverse their direction with respect to the zero reference

The sine wave

If we carefully examine a sine wave (the most common of these a.c. waves) we see that the current starts at zero, gradually rises to a maximum value and then returns to zero to complete the first half of the cycle. Thereafter, the current reverses its direction of flow, rises gradually to a peak in the other direction, and again returns to zero to complete the full cycle. In a pure sine wave the maximum value in one direction is the same as the maximum peak in the other.

When we refer to the value of a sine wave we generally speak of its "effective" value, which is considerably less than its maximum value. To convert from one value to another, the following approximate formulas are used:

E effective=.7×E peak

E peak=1.4×E effective

Thus, when we speak of our house voltage as having an effective voltage of 120 volts, the actual peak voltage is 1.4×120, or approximately 168 volts.

If an a.c. voltage is applied across a resistor, the current through the resistor will vary in the same pattern as the applied voltage. A sine wave of voltage will produce a sine wave of current. The relationship between current, voltage, and resistance in an a.c. circuit is the same as for a d.c. circuit, and the same Ohm's law formulas apply.

As in d.c., the resistance of a circuit limits the amount of current that can flow for a certain value of applied voltage. However, in an a.c. circuit we have two other types of components which can limit the amount of current. These are called capacitors (condensers) and inductors (coils).

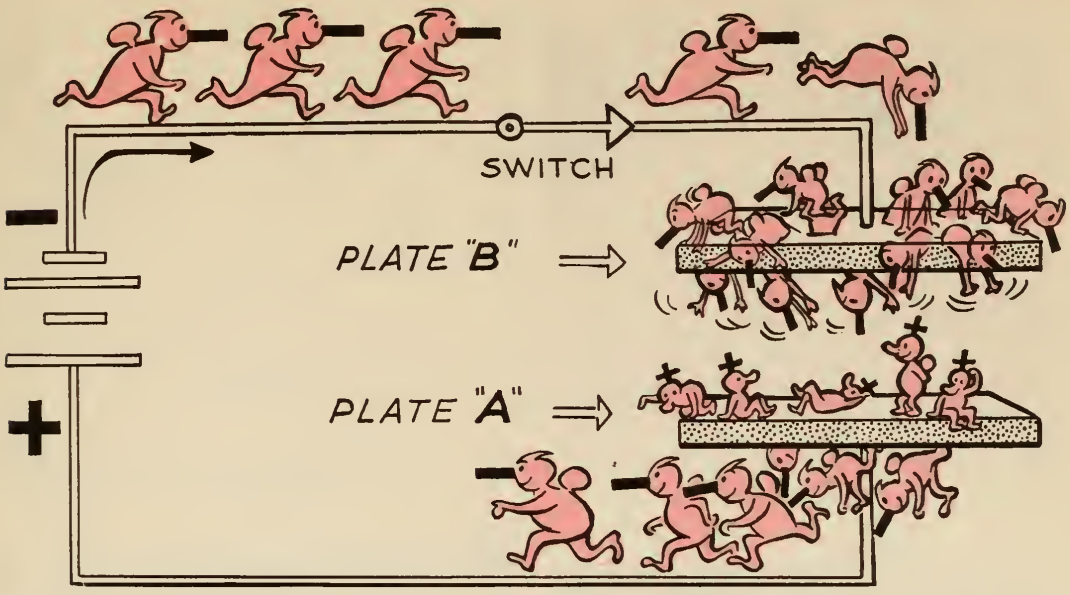
Capacitors

Physically, a capacitor consists of two pieces of conductive material, separated by insulation. The action of a capacitor, when a voltage is applied to it, can be explained as follows:

Suppose a battery is connected across a capacitor as shown in Fig. 9. At the instant that the switch is closed, the positive terminal of the battery will attract the electrons from plate A of the capacitor so that current will flow from this plate into the battery. As a result plate A will be positively charged. Since any current entering the battery must also leave the battery from the other terminal, the negative terminal will push electrons into plate B of the capacitor. Therefore, plate B will have an excess of electrons and will be charged negatively.

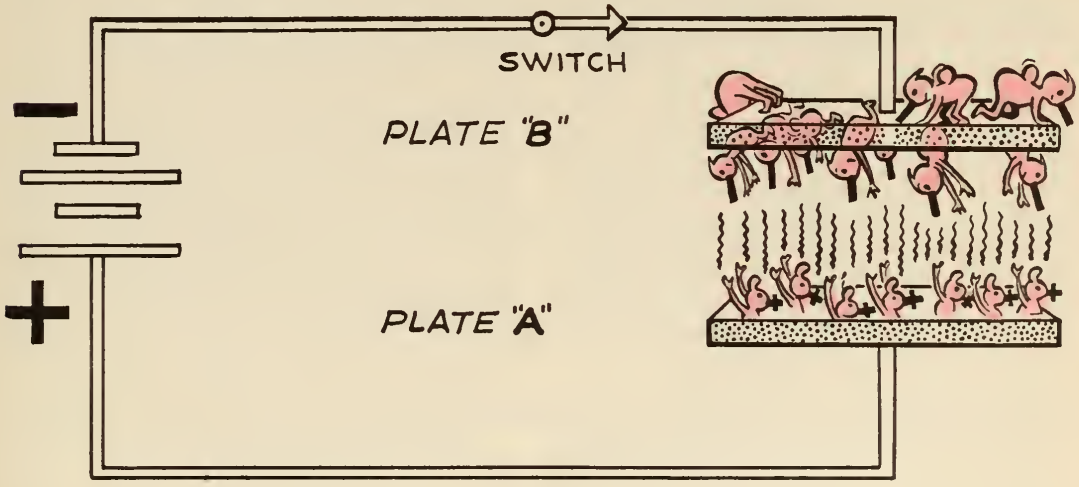
The excess electrons from plate B are prevented from passing to plate A by the insulating material between the two plates. This results in a difference of electrical pressure (voltage) between the capacitor plates.

When the voltage across the capacitor has reached the same value as the battery voltage, the current flow in the circuit will stop altogether, and the capacitor is said to be fully charged. If we now disconnect the battery from the capacitor and replace it with a resistor, the capacitor acts as a battery and causes current to flow through the resistor until all of the excess electrons



A capacitor connected across a d.c. voltage source permits current flow only until it is fully charged

When fully charged, insulating material between the capacitor plates prevents continuous current flow



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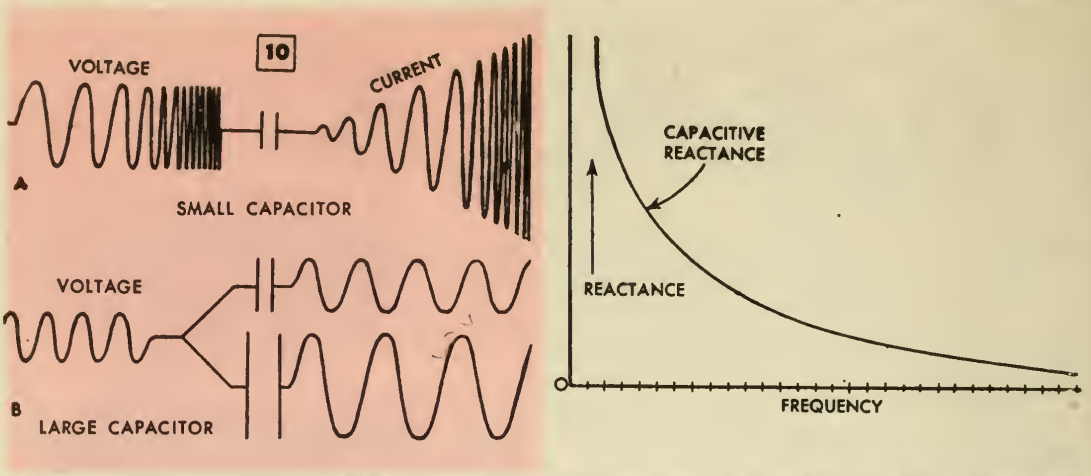
from plate B have returned to plate A. Then, current will again cease.

Since it takes only a very short period of time to charge a capacitor from a d.c. voltage source, current flow will stop almost instantly. For a d.c. voltage, therefore, the capacitor will represent an open circuit, preventing any continuous current flow. However, if a capacitor is connected across a source of a.c. voltage, it will charge up first in one direction and then in the other, due to the constantly changing polarity of the applied voltage. As a result, there will be a continuous reversal of current in the circuit which makes it appear as though a.c. current is actually flowing through the capacitor. This is not strictly true, but the result is identical. A capacitor, therefore, permits alternating-current flow.

The amount of alternating current which flows in a capacitive circuit depends upon the opposition the capacitor introduces.



A capacitor's opposition to a.c. depends upon its electrical size and the frequency of the applied voltage

This opposition is called "reactance" which is another word for a.c. resistance, or resistance to a.c. current. Since, in this particular instance, the reactance is produced by a capacitor, it is called "capacitive reactance" (abbreviated Xc).

The value of Xc depends upon the electrical value of the capacitor and the frequency of the applied voltage. Mathematically, we can say that $Xc=\frac{.159}{FC}$; where Xc=Capacitive reactance, F=Frequency of applied voltage and C=Capacity value in Farads. From this formula it can be seen that as the frequency increases, the capacitive reactance for a given value of capacity decreases. Likewise, if we increase the value of capacity, its reactance decreases at any given frequency, Fig. 10.

These principles are extremely important in radio work, as you shall see later.

The basic unit of measure of a capacitor is the "farad." In radio work, however, such a large value of capacity is never used. A much smaller measure of capacity must, therefore, be employed. Accordingly, the terms microfarad (mfd.) and micro-microfarad (mmfd.) have been adopted. One microfarad is equal to one-millionth (.000001) of a farad, while a micro-microfarad is one-millionth of a microfarad. You will be come quite familiar with these terms as you progress in your radio work.

Inductance

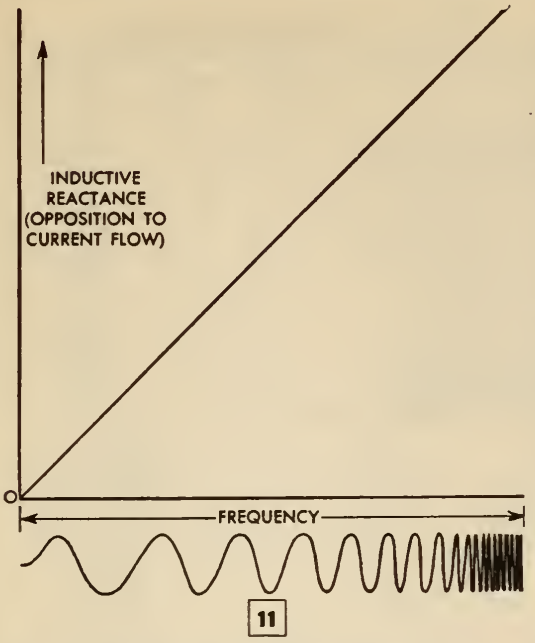
Another type of unit that introduces an opposition to alternating current is an inductor. Actually, this is nothing more than a piece of wire (a conductor) which is wound in the form of a coil, yet, the properties of such a unit are quite different in a d.c. circuit than they are in an a.c. circuit.

When a coil of wire is connected across a battery the only opposition to the flow of current is the resistance in the wire. This resistance is very small, so that a very large amount of current will flow. If this same coil is connected across an a.c. generator of the same voltage, however, the amount of current through the circuit will be greatly reduced. This is due to the fact that the coil introduces a reactance, or a.c. resistance, into the circuit which will further decrease the amount of current flow. This a.c. resistance is called inductive reactance and is abbreviated X_L. The formula for this is, $X_L=6.28\times FxL$; where X_L=Inductive reactance in ohms F=Frequency in cycles per second and L=Inductance in henrys.

The *inductance* value of a coil depends upon the number of turns of wire in the coil, the spacing of the turns and the length and diameter of the coil. If we examine the graph in Fig. 11 we see that for a given value of inductance the inductive reactance varies directly with frequency. If the frequency increases, the coil's reactance also increases. At a given frequency, the larger the inductance, the greater its reactance. It can be seen, therefore, the properties of an inductor are almost directly opposite to those of a capacitor.

Resonance

While an exact analysis of resonance is somewhat involved, the effects of reso-



Coil's opposition to current increases with frequency

nance can easily be observed. In fact, it is the resonance effect which permits us to "tune in" the various stations on our radio.

As noted earlier, the opposition to current flow offered by an inductor increases as the frequency of the applied voltage increases. The opposition offered by a capacitor, however, decreases with an increase in frequency. These changing reactances for an applied signal frequency are shown in Fig. 12. Regardless of the individual values of L and C, there is some frequency at which the reactances of the two are equal. This is called the resonant frequency.

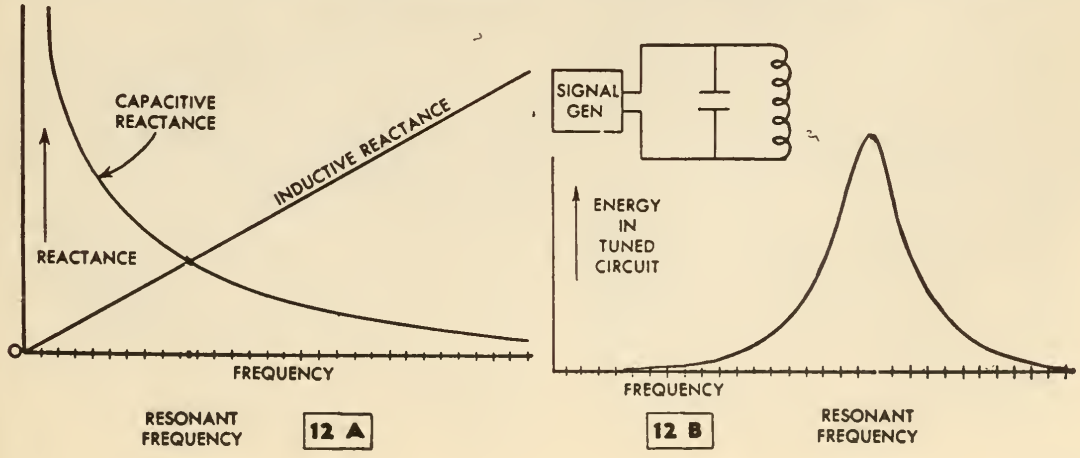
When a signal generator is applied across a circuit containing a coil and capacitor, maximum energy will be transferred from the generator to the circuit only at the resonant frequency. At frequencies above and below this resonance point, the energy transfer will be relatively small.

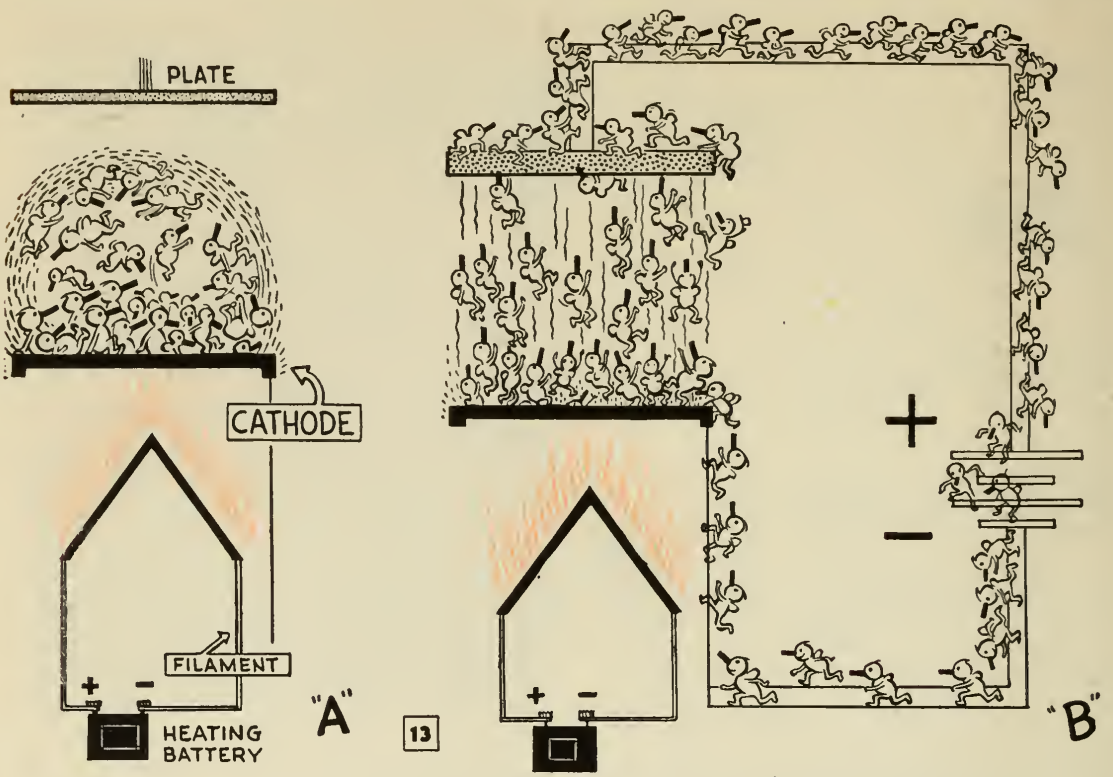
A radio antenna can be considered as a generator capable of providing signals whose frequencies are equal to those of the various transmitting stations. If a tuned circuit (one containing inductance and capacitance) is connected to the antenna, maximum energy will be extracted only from the signal whose carrier frequency is equal to the resonant frequency of the circuit. However, if the capacitance is made variable, so that its reactance can be changed, it can resonate with the inductive reactance at any desired frequency within a given range. This permits us to actually "tune in" the various stations in a particular band.

Vacuum tubes

So far, you have seen that electrons can be made to move through a circuit consisting of resistance, inductance and capacitance, or all three, by the application of an external voltage. However, there are other ways of causing electron motion. One of these, a method used in most vacuum tubes, is by thermal agitation. A basic vacuum tube consists of a filament, a cathode and a plate. These three elements are enclosed in an envelope, either metal or glass, from

A tuned circuit is resonant at the frequency when XL equals Xc, as shown in Fig. 12A. Figure 12B, below, shows that such a circuit extracts maximum energy from a generator only at the resonant frequency





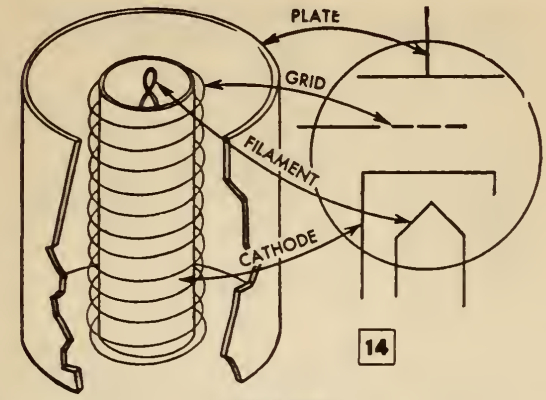
which air has been removed. Operation of this tube (called a diode) is shown in Fig. 13.

When a voltage is applied to the tube filament, the resultant current heats the filament to a very high temperature. This heat is transmitted to the cathode surrounding the filament. The cathode is made of a special material containing many free electrons which are easily agitated by heat. In fact, when the cathode is heated, its electrons gain so much energy that they literally break through the surface barrier of the cathode into the surrounding space. Naturally, in breaking this barrier the electrons lose most of their energy and quickly fall back to the cathode, only to be "boiled off" again. As a result of this continuous action, there is a virtual cloud of electrons surrounding the heated cathode at all times. This cloud of electrons is called the *space charge,* since it charges the space around the cathode to a negative potential.

As long as there are no other forces acting upon the electrons of the space charge, they will continue to fall back to the cathode. However, if a positive voltage is applied between the plate and cathode of the tube, many of the electrons in the space charge will be attracted to the plate. As a result, there will be a continuous flow of current from the cathode to the space charge, to the plate, and back to the cathode again. The greater the voltage on the plate, the more space-charge electrons will be attracted to the plate, and the amount of plate current will increase as the plate voltage is increased. However, when the plate voltage is large enough to attract all of the space-charge electrons any additional increase in plate voltage will cause no further increase in plate current. This is called the saturation point of the tube.

The diode tube

Plate current will flow in a diode tube (a simple vacuum tube) as long as the plate is positive with respect to the cathode. If the plate were made negative, you might think that electrons would be attracted from the plate to the cathode. However, this is not the case. Since the plate is not heated, it does not throw off any electrons of its own as does the cathode. Therefore, there can be no plate current flow in the reverse direction. This characteristic of a diode has several important applications in radio and electronics since it can be used, for example, for the detec-



TRIODE TUBE

The grid of the triode tube, when negative, acts as a barrier to the space-charge electrons. The more negative the grid voltage, the smaller the plate current

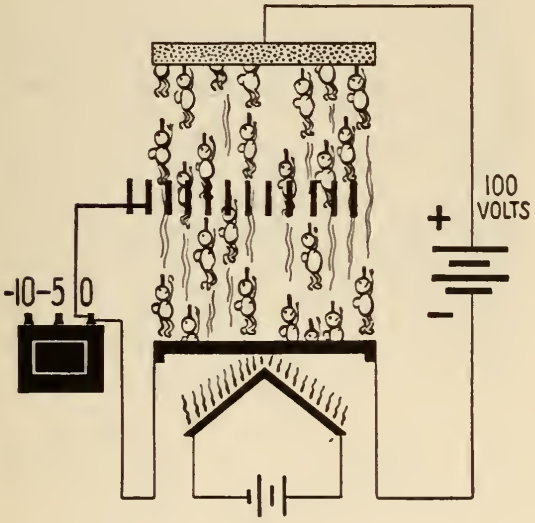
tion of a radio signal and the conversion of a.c. voltages to d.c.

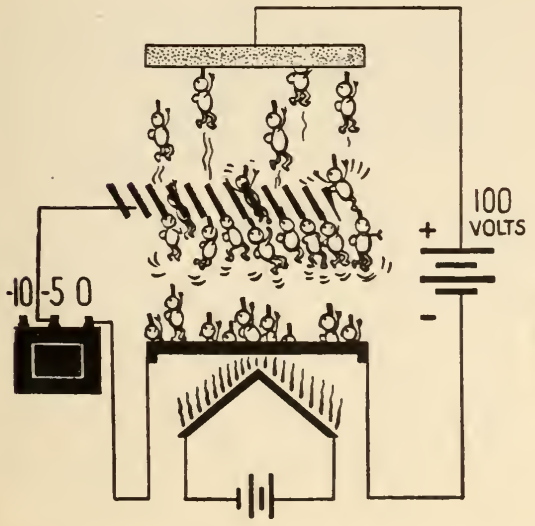
The triode tube

One of the most important functions of a vacuum tube is the amplification of radio signals. A diode tube can "rectify" or "detect," a signal, but it can not amplify it. To accomplish this important function, another element, a grid, has been added to the tube. The grid is a fine wire mesh which is inserted between the cathode and the plate of a diode. The resulting tube shown in Fig. 14 is called a triode.

Dr. Lee DeForest, often called the father of radio, found that the insertion of a grid permits the tube's plate current to be controlled by a voltage on the grid as well as a voltage on the plate. In fact, since the grid is much closer to the space charge than the plate, the grid voltage is much more effective in controlling the amount of plate current than is the plate voltage itself.

Consider a diode tube with a positive 100 volts applied between plate and cathode. Under this condition, we know that a certain number of space-charge electrons will be attracted to the plate. Now, if we insert a grid between the cathode and plate so that the distance between grid and cathode is one-tenth the distance between plate and cathode, the grid voltage will be about 10 times as effective as the plate voltage in changing the plate current. In fact, if we apply a negative 10 volts on the grid, this voltage will repel the electrons back to the cathode with as much force as the





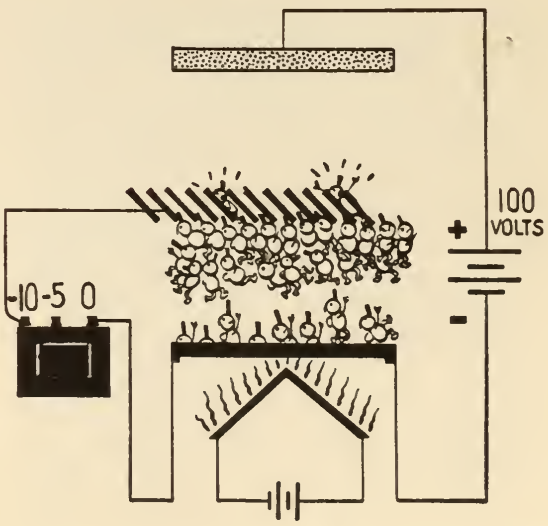


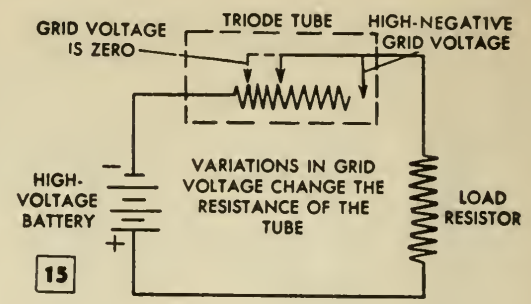
plate voltage will attract them. As a result, there will be no plate current flow at all; just as if the plate voltage itself were zero. For negative grid potentials between 0 and −10 volts, the plate current will vary as if the plate potential were actually changed between 0 and 100 volts.

If we place a negative 5 volts on the grid of the tube in this example and a positive 100 volts on the plate, the apparent plate attraction to the space-charge electrons will be only about 50 volts. As the grid voltage is varied from −5 to 0 and again to −10, the apparent attraction of the plate will change from 50 to 100 and 0 volts respectively. The resultant plate current, when flowing through an appropriate plate load resistor can develop an output voltage across this resistor which varies in accordance with the amount of plate current flow. As a result, an a.c. grid voltage with a peak amplitude of 5 volts could produce an output signal voltage with a peak amplitude of about 50 volts. The gain or amplification of this particular tube, therefore, is 10, because the output signal is 10 times as large as the input signal.

Pictorially, we can consider a triode tube as a variable resistor between a battery and a load resistor, as shown in Fig. 15. When the voltage between the grid and cathode of the tube is zero, the resistance of the tube is very low so that most of the voltage is dropped across the load resistor and very little voltage appears across the tube. When the grid voltage is highly negative, the tube is essentially an open circuit so that all of the battery voltage is dropped across the tube and no voltage appears across the load. Since only a small grid voltage change is required to vary the apparent tube resistance from a very low to a very high value, a small a.c. signal on the grid will cause a large a.c. variation of voltage on the plate. The signal on the grid, therefore, appears at the plate in greatly amplified form.

Fig. 16 shows a typical amplifier circuit. Here a small a.c. signal is applied between grid and cathode of the tube. This signal is actually in series with a small battery whose positive terminal is connected to the cathode. The battery places a small initial negative voltage (called bias) on the grid. This voltage will vary, becoming more or less negative, as the signal is applied.

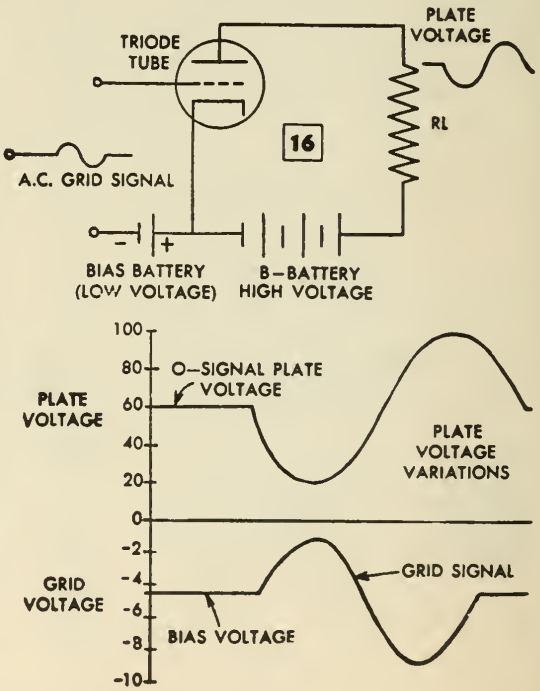
When no signal is applied, the voltage of the plate battery is divided between the

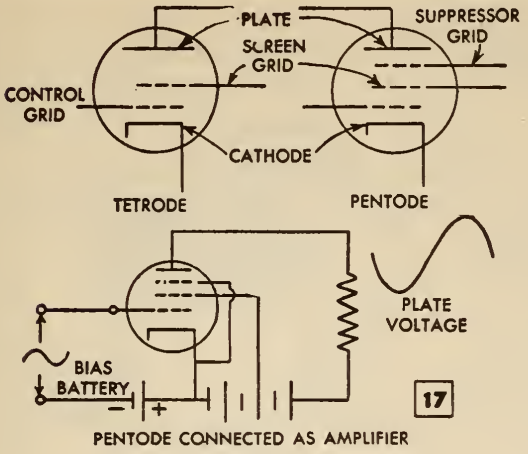


tube and the load resistor. As the grid signal goes positive, the bias voltage approaches zero, causing the tube resistance to decrease greatly. When this occurs, the ratio between tube and load resistance changes so that most of the plate-battery voltage is dropped across the load resistor. Under this condition, the plate voltage drops from about 50 volts to almost zero.

When the grid signal reverses its direction making the bias much more negative than originally, the tube resistance is greatly increased. Therefore, most of the plate-battery voltage appears across the tube.

During the full cycle of the applied signal voltage (10 volts peak-to-peak) the plate voltage in this example will vary from almost zero to 100 volts. The small grid signal appears at the plate in amplified form.





PENTODE CONNECTED AS AMPLIFIER

Tetrodes and pentodes

Although triode tubes can provide a considerable amount of amplification, they produce certain problems. One of these is the relatively high interelectrode capacity which appears between the plate and grid of such a tube. As a result of this, some of the output voltage can be fed back to the grid, at high frequencies, and produce oscillations. The plate-to-grid capacity of a tube can be reduced by inserting another grid, Fig. 17, between the first grid and the plate. This second grid is called the screen grid because it effectively shields the control grid from the plate and thus reduces the capacity between these two elements. This makes the tube far more valuable as an amplifier at high frequencies, and, at the same time, increases the amount of amplification which can be obtained to a much higher value. The screen grid is usually connected to a positive voltage source. Tubes incorporating both a control and a screen grid are called tetrodes.

Since the screen grid of a tetrode is made positive with respect to the cathode, this grid also exerts an attracting force on the space-charge electrons. These electrons are therefore given a tremendous amount of acceleration, and will strike the plate with such a force that they can dislodge some electrons within the material of the plate. These dislodged electrons will travel from the plate to the screen grid and actually reduce the amount of plate current at certain critical plate voltages. To prevent this secondary emission of plate electrons, a third grid is placed between the plate and the screen. This grid, called the suppressor grid, is generally connected to a point that is negative with respect to the plate. Therefore, the electrons being dislodged from the plate will be repelled back to the plate by the suppressor grid. In this way the adverse effects of the screen grid are neutralized while all of its advantages are retained. Tubes incorporating suppressor grids are called pentodes, and these are currently the most popular types for high-frequency amplification.

BASIC RADIO RECEIVERS

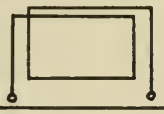
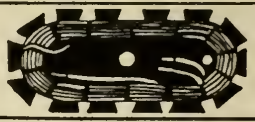
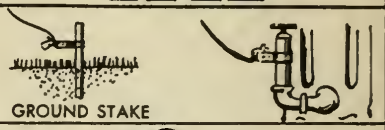
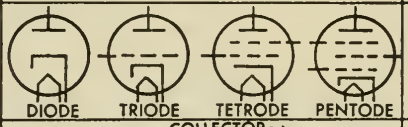
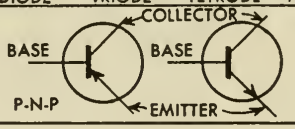
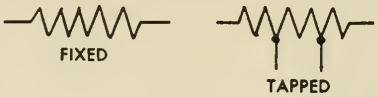
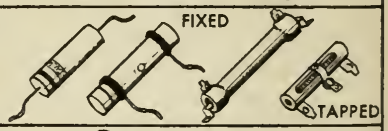
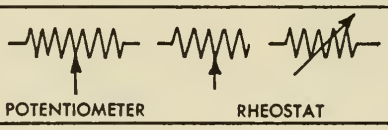
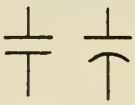
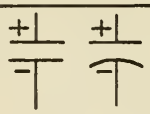
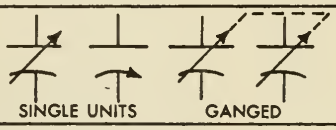
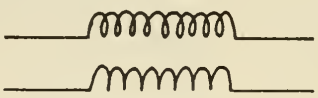
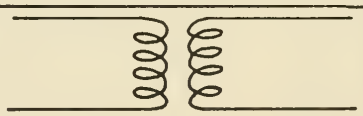
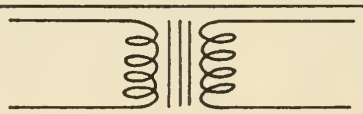
Now that you know how some of the parts used in a radio operate, we can take a look at a few typical radio receivers. Before doing this, however, you will have to learn some of the symbols associated with radio parts, and how to read schematic diagrams.

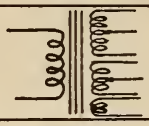
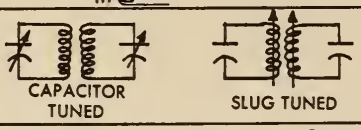
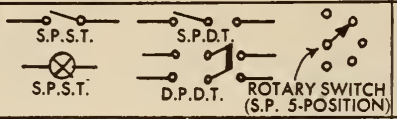
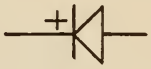
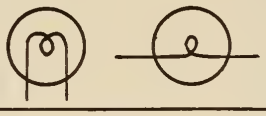
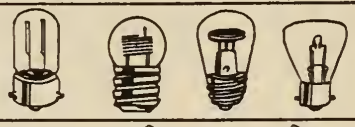
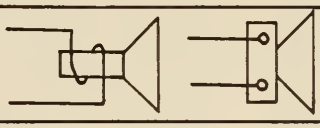
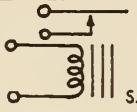
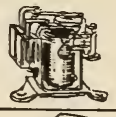
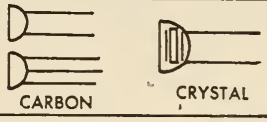
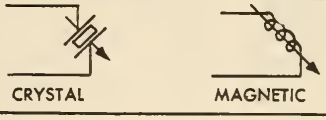
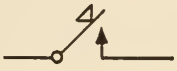
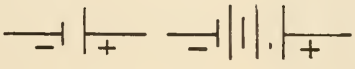
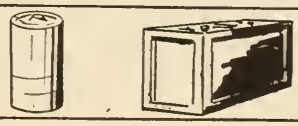
Just as a map maker uses symbols to illustrate roads, rivers, and other landmarks, the radio man uses symbols to identify the various radio parts. These symbols, when properly arranged, show the experienced technician how a particular piece of electronic equipment is wired, just as a road map shows the traveler what he is likely to encounter. The electrical wiring map is called a schematic diagram.

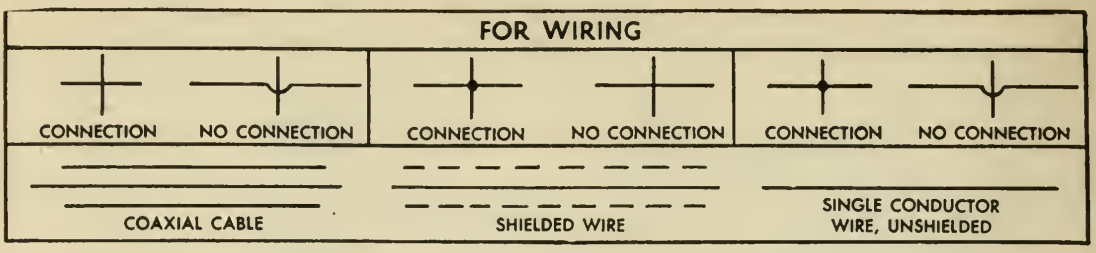
To learn how to read a complicated schematic requires considerable practice, but we can illustrate the usefulness of such diagrams by using one of them in discussing the operation of the simplest of all radios—the crystal set. If you cannot identify some of the symbols, you can check these against the symbol list shown in Fig. 18 and write their names beside the corresponding symbol in the actual schematic. By doing this every time you come in contact with a schematic, you will soon learn to recognize them without any difficulty.

The crystal set

As you have learned previously, all it takes to convert a radio signal into audible sound is a means for separating the audio frequencies from the carrier wave and a

NAME	SCHEMATIC SYMBOL	PHYSICAL APPEARANCE
ANTENNA (OUTDOOR)		
LOOP ANTENNA	 (USUALLY BUILT IN RECEIVER CABINET)	
GROUND (OR CHASSIS CONNECTION)		 GROUND STAKE
TUBES	 DIODE TRIODE TETRODE PENTODE	
TRANSISTOR	 COLLECTOR BASE BASE P-N-P EMITTER N-P-N	
RESISTOR	 FIXED TAPPED	 FIXED TAPPED
POTENTIOMETER RHEOSTAT	 POTENTIOMETER RHEOSTAT	
CAPACITOR (FIXED)	 (PAPER, MICA, CERAMIC)	PAPER TUBULAR MICA CERAMIC
CAPACITOR (ELECTROLYTIC)		
CAPACITOR (VARIABLE)	 SINGLE UNITS GANGED	
COIL OR CHOKE (AIR CORE)		
COIL OR CHOKE (IRON CORE)		
TRANSFORMER (AIR CORE) USED AT RADIO FREQUENCIES		
TRANSFORMER (IRON CORE) USED AT AUDIO FREQUENCIES		

NAME	SCHEMATIC SYMBOL	PHYSICAL APPEARANCE
TRANSFORMER (IRON CORE–MULTI-WINDING) USUALLY USED AS POWER TRANSFORMER		
TRANSFORMER (DOUBLE TUNED) USED AS INTERMEDIATE FREQUENCIES—I.F.		
SWITCH		
RECTIFIER SELENIUM, GERMANIUM, CRYSTAL TYPE, ETC.		
LAMP PILOT, NEON, ETC.		
FUSE		
HEADPHONES		
SPEAKER (PERMANENT MAGNETIC)		
LINE CORD WITH PLUG		
RELAY		
MICROPHONE		
PHONO PICKUP		
TELEGRAPH KEY		
BATTERY		

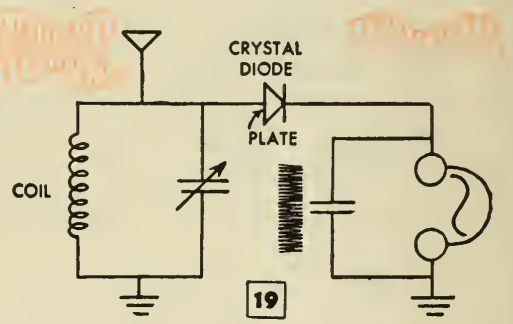


unit to convert the resulting current waves into equivalent sound waves. These basic purposes are accomplished in a crystal receiver which, in the early days of radio, was used exclusively for radio reception.

The schematic diagram of a simple crystal set is shown in Fig. 19. Here, the receiving antenna is connected to a circuit consisting of a variable capacitor and a coil hooked in parallel. As the antenna extracts a small amount of energy from the passing radio signals, minute electrical currents corresponding to the frequencies of the various signals pass from the antenna to ground. In doing so, they must pass through the tuned circuit of the coil and capacitor. Now, the tuned circuit will extract energy only from the signal whose frequency is equal to the resonant frequency of the circuit. As a result, a signal from any other station will pass directly to ground without inducing any voltage into the tuned circuit.

The resonant frequency signal, however, will produce a voltage across the circuit which is identical to the wave of the signal itself. Since the capacitor of the tuned circuit is variable, we can tune the circuit to resonance for any desired station, and this permits us to select one particular station from the many whose signals are present at the antenna.

The signal voltage developed across the tuned circuit is applied to a crystal diode in series with a pair of headphones. The diode, whether crystal or vacuum tube, permits current to flow only when its plate is positive with respect to its cathode. Thus, current can flow through the headphones and diode only during the positive-going alternations of the applied signal, and the signal is said to be rectified, or detected. The final separation between the carrier frequency and the audio signal is accomplished by the capacitor which is connected across the headphones. This capacitor has a very low reactance to the high carrier frequency but a high reactance to the low audio. As a result, the carrier currents flow only through the capacitor and are directed around the phones. The audio, however, goes directly through the phones and is converted into corresponding sound waves.



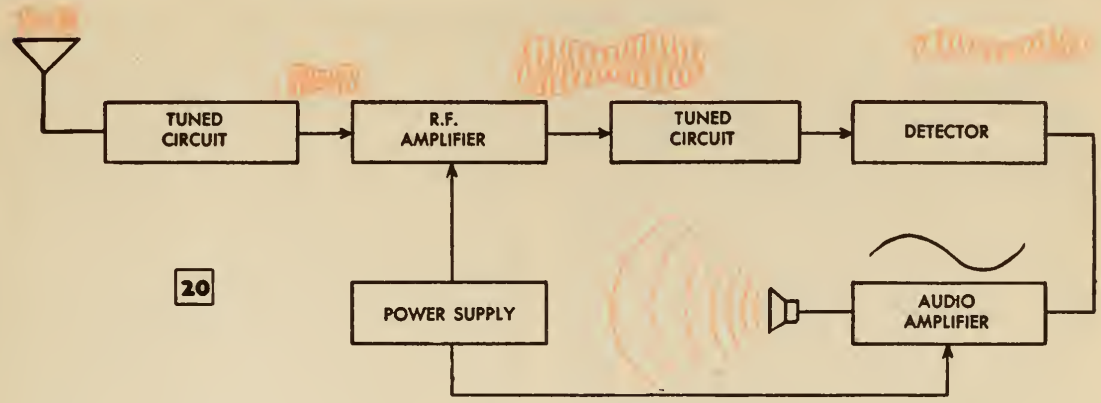
Tuned, radio-frequency receivers

A basic crystal set has several disadvantages. Since it provides no signal amplification, it can be used only for the reception of powerful, nearby stations. Furthermore, since only one tuned circuit is used, it often becomes difficult to separate stations which are close together in the frequency spectrum. These disadvantages are overcome in a tuned, radio-frequency (T.R.F.) receiver.

A block diagram of a T.R.F. receiver is shown in Fig. 20. This type of set is far more complicated than the crystal set, but it provides excellent "sensitivity" (the ability to pick up distant stations) and selectivity (the ability to separate stations).

The radio signal picked up at the antenna delivers a voltage to a tuned circuit. Instead of being detected immediately, however, this signal is first amplified by one or more amplifier stages. Each one of these incorporates an additional tuned circuit so that the signal receives considerable "preselection" before being detected. After detection, a number of audio amplifiers increase the strength of the audio signal to the point where it is strong enough to drive a loudspeaker.

In all previous descriptions, we have used batteries to obtain the various d.c.



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voltage required for operating the vacuum tubes. In order to eliminate these from modern radios, a special circuit was devised which converts the regular commercial a.c. line voltage into d.c. This circuit is called the power supply. It is used in all commercial sets other than portable radios.

Superheterodyne receivers

A superheterodyne receiver, though basically similar to a T.R.F., operates on a slightly different principle. This circuit offers such a decided improvement in amplification, sensitivity and selectivity that it is used in almost every modern receiver.

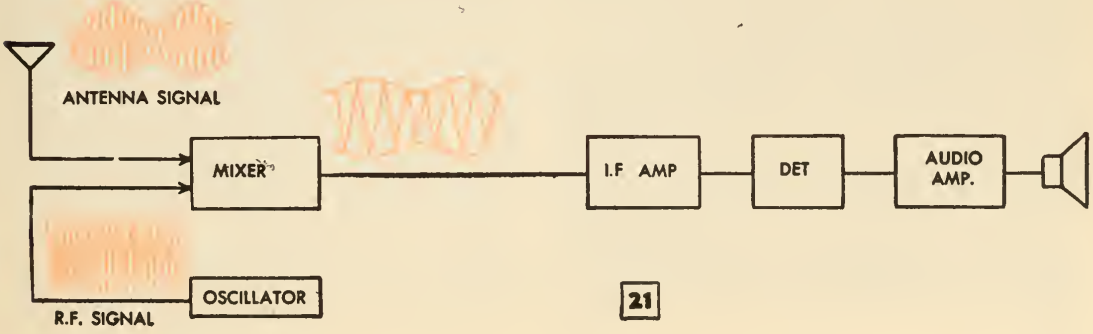
When two signals are applied to a vacuum tube operated under certain conditions, the output of the tube contains not only the two applied signals, but also the sum and difference frequencies between the two signals. The process by which this is done is called heterodyning. If the output circuit of such a tube is tuned to the difference frequency, only this particular frequency will develop an output voltage.

Fig. 21 shows the block diagram of a simple superhet receiver. Here, the radio signal picked up by the antenna is applied to a mixer tube where it is combined with the signal from a local oscillator. As in a transmitter, the oscillator generates a pure r.f. signal which is constant in amplitude. When this signal is mixed with the antenna signal, the output of the mixer tube will contain currents equal to the difference between the two frequencies. This is called the *intermediate frequency* (i.f.).

The i.f. signal contains all of the modulation which was present in the original radio signal, but its carrier frequency will be much lower. Furthermore, since the antenna and oscillator tuned circuits are always varied in step with one another (when the receiver is tuned to a higher station, the oscillator automatically generates a higher frequency), the i.f. frequency will be the same for all radio signals. As a result, the i.f. amplifiers can be designed to have a much higher amplification than the r.f. stages in a T.R.F. receiver.

Following the i.f. amplifiers, the stages in a superhet are identical to those of a T.R.F.

The foregoing discussion is intended to familiarize you with the basic principles of radio and the operation of some types of receivers.



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A GLOSSARY OF TERMS

AMMETER. An instrument for measuring the current flow in amperes in a circuit.
AMPERE. The practical unit for measuring flow of current. When a one-ohm resistance is connected to a one-volt source, one ampere will flow.
ANODE. The radio-tube electrode to which the main electron stream flows. It is commonly called the plate, and is identified by the letter P.
ANTENNA. An arrangement of conducting wires or metal rods used for picking up, or radiating, radio waves. Also called an aerial.
AUDIBLE. Sound capable of being heard by the human ear.
AUDIO AMPLIFIER. Any vacuum-tube device which increases the voltage and power of an audio-frequency (a.f.) signal. It may be a separate unit, or the audio section of a radio receiver.

AUDIO FREQUENCY. A frequency corresponding to an audible sound wave. The extreme limits vary with individuals; range is from about 20 cycles to about 20,000 cycles per second.
AUDIO TRANSFORMER. An iron-core transformer used for coupling two audio-amplifier circuits together, or, for changing values of audio signals.
AUTOMATIC VOLUME CONTROL. A radio circuit which automatically maintains the output value of a radio receiver constant within certain limits while the carrier signal picked up by the antenna varies widely in amplitude.
BACKGROUND NOISE. Undesired noise heard along with received radio programs. Due to circuit conditions, or atmospheric interference.
BAFFLE. A flat surface of wood or metal used with a loudspeaker to increase the length of the air path from the front to the back of the loudspeaker diaphragm, thus reducing interaction between sound waves produced simultaneously from the front and back surfaces of the diaphragm. Also directs sound, and improves the fidelity of reproduction.
BAKELITE. A phenolic compound having high electrical resistance. Used as an insulating material in the construction of radio parts and panels.
BANDSPREAD TUNING CONTROL. A small variable condenser connected in parallel with the main tuning condenser of a short-wave receiver for the purpose of finer or more accurate tuning.
BAND SWITCH. A switch which simultaneously changes all tuning circuits of a radio receiver or transmitter to other desired predetermined bands.
B-BATTERY. A battery having many small cells connected in series, used for supplying d.c. plate and screen voltage to radio tubes in battery-operated radio and electronic equipment.
BEAM POWER-AMPLIFIER TUBE. A special type of vacuum tube for use in the output stage of a radio receiver. Deflecting electrodes concentrate the electrons into beams to give high power output with good quality.
B-ELIMINATOR. An a.c. power pack which is designed to convert a.c. power-line voltage to d.c. voltages of correct plate and screen values for tubes in circuits formerly supplied by B-batteries.
BIAS. The fixed negative grid voltage (commonly called grid bias) for an electron tube.
BLOCKING CONDENSER. Any condenser used in a radio circuit to block the flow of current while permitting a.c. signal currents to pass.
BY-PASS CONDENSER. Any condenser used to provide a low-impedance path for radio or audio signals to pass around a resistor or between a circuit terminal and ground.
CAPACITIVE COUPLING. Coupling in which a condenser provides a direct path for signal energy between two circuits.
CAPACITOR. Condenser of any type.
CAPACITY. The electrical size of a condenser, determining the amount of electrical energy which can be stored in a condenser by a given voltage. Capacity is measured in microfarads (mfd.) and micromicrofarads (mmfd). Note—1 mfd. is equal to 1,000,000 mmfd.
CARBON RESISTOR. A resistor made of carbon particles and a ceramic binder molded into a cylindrical shape, with wire connecting leads at each end.
CATHODE. The negative pole or electrode of an electrolytic cell, vacuum tube, etc. Identified by the letter K.
C-BATTERY. A battery used for supplying a negative C-bias to the control grid of a vacuum tube.
C-BIAS. An applied voltage used to make the control grid of a vacuum tube negative with respect to the cathode.
CHASSIS. A metal framework on which the parts of a radio receiver or any radio or electronic device are mounted.
CHOKE COIL. A coil used to limit the flow of alternating current while allowing direct current to pass. R.f. choke coils have air cores; a.f. choke coils have iron cores.
COAXIAL CABLE. A two-conductor cable in which one conductor is a flexible or non-flexible metal tube and the other is a wire supported in the center of the tube by insulators.
COLOR CODE. A system of colors used to specify the electrical value of a radio part, or to identify terminals and leads. R.M.A. code is standard.
CONDENSER. A device having the ability to receive and hold an electrical charge in two conductors separated from each other by insulation, called the dielectric, through which the two conductors, or plates, exert an inductive effect. The dielectric may be air, mica, oil, ceramic or a plastic material.
CONDUCTIVITY. The ability of a material to carry electric current.
CONDUCTOR. A wire or other metallic structure which provides a path for electric current between two points. A good conductor offers little opposition to the continuous flow of electric current.
CONTINENTAL CODE. Same as International Morse Code. Universally used for radio telegraphy.
CONTROL GRID. The electrode in a vacuum tube which has the most effective control over the plate current passed by the tube.
COULOMB. A measure of the amount of an electric current, being the quantity transferred in one second by a current of one ampere.
CRYSTAL CONTROL. Use of a quartz crystal to maintain operation of a radio station at its assigned frequency within the limits prescribed by law. The quartz crystal is ground to a size which will vibrate naturally at a desired radio frequency and generate that frequency when it is set into vibration.
CRYSTAL DETECTOR. A detector of radio signals utilizing a crystal such as silicon or galena in contact with a pointed wire to rectify an incoming radio signal. Used in crystal receivers.
CRYSTAL PICKUP. A type of phonograph pickup in which the needle movements bend a quartz crystal and cause the crystal to generate an audio-frequency voltage corresponding to the recorded sound waves.
CURRENT. The movement of electrons through a conductor. Current is measured in amperes, in milliamperes and in microamperes.
CUTTING HEAD. The part of a sound recorder which cuts the irregular grooves on a blank record disk, corresponding to the wave form of the sounds being recorded.
CYCLE. One complete reversal of an alternating current, including a rise to maximum in one direction, a return to zero, the rise to maximum in the other direction, and another return to zero. The number of cycles occurring in one second is the frequency of an alternating current.
DIELECETRIC. The insulating material between the plates of a condenser.
DIODE. A vacuum tube with a cold anode and a heated cathode, serving as a rectifier.
DROP. The voltage drop that occurs across a resistor due to current flow through the resistor.
DX. A slang expression for distance, used chiefly in connection with the reception of distant radio stations.
DYNAMIC LOUDSPEAKER. Any loudspeaker in which the diaphragm or cone is attached to a small coil mounted so that it can move within a constant magnetic field. Audio-frequency currents flowing through this "voice" coil make it move in and out, thereby causing the diaphragm to reproduce sound waves. In permanent-magnet (PM) speakers, the magnetic field is produced by a permanent magnet; and by an electromagnet in electrodynamic speakers.
ELECTRIC FIELD. A region in space surrounding a charged object. Lines drawn to represent the direction in which the electric field will act on other charged objects are called electric lines of force.
ELECTROLYTE. The liquid or chemical paste which is used between the electrodes of a dry cell, storage battery or electrolytic condenser.
ELECTRON. The most elementary charge of negative electricity; the electrical opposite of the proton.
ELECTRONICS. A broad field of electricity covering work with all types of apparatus employing electron tubes for industrial applications. Radio and television are major branches of the electronic field.

ELECTRON TUBE. Any partly evacuated, completely evacuated or gas-filled tube used to control the flow of electrons in a circuit. Vacuum tubes, phototubes, mercury-vapor rectifier tubes and cathode-ray tubes are all electron tubes.

FACSIMILE. A system of radio communication in which photographs, drawings and printed matter of any kind are transmitted to receivers which feed into facsimile recorders.

FACSIMILE RECORDER. An instrument which reproduces on paper the illustration, writing or printed matter being transmitted by a facsimile system.

FAHNESTOCK CLIP. A spring-type terminal to which a temporary connection can be easily made.

FARAD. The unit of electrical capacity; the capacity of a condenser which, charged with one coulomb, gives a difference of potential of one volt.

F.C.C., OR FEDERAL COMMUNICATIONS COMMISSION. A commission appointed by the President of the United States and given licensing and regulating authority on matters dealing with wire and radio communication in the United States and its possessions.

FILAMENT. The resistance wire through which the filament current is sent in a vacuum tube to produce the heat required for electron emission.

FILTER CHOKE. A coil used in a filter system to pass low-frequency currents or direct current while limiting, or blocking, the flow of higher frequency alternating or pulsating currents.

FILTER CONDENSER. A condenser used in a filter system to permit passage of higher frequency currents while limiting, or blocking, the flow of lower frequency currents and direct current.

FIRST AUDIO STAGE. The first stage in the audio amplifier of a radio receiver. Audio signals are fed into this stage by the detector of a T.R.F. (tuned-radio-frequency) receiver; and by the second detector of superheterodyne receiver.

FIRST DETECTOR. That stage in a superheterodyne receiver in which the incoming modulated r.f. signal and the r.f. signal from the local oscillator are combined to produce the i.f. (intermediate frequency) signal.

FULL-WAVE RECTIFIER. A radio tube or other device which rectifies an alternating current in such a way that both halves of each input a.c. cycle appear in the pulsating rectified output. A full-wave rectifier tube employs two separate diode sections, one passing current during one alternation, and the other passing current during the opposite half-cycle.

GANGED TUNING CONDENSER. Two or more variable tuning condensers mounted on the same shaft and operated by a single control.

GRID. An electrode mounted between the cathode and the anode (plate) of a radio or electronic tube to control the flow of electrons from cathode to anode.

GRID CLIP. A spring clip used to make a convenient and easily removed connection to the cap terminal located on the top of some types of radio tubes.

GRID CONDENSERS. A small fixed condenser inserted in the grid circuit of a vacuum tube.

GRID LEAK. A high-value resistor used to connect the control grid to the cathode, in a grid leak condenser circuit.

GRID RETURN. The connection or lead that provides a path for electrons from the grid circuit, or C-bias battery, to the cathode.

GRILLE CLOTH. A loosely woven cloth stretched behind the loudspeaker grille of a radio receiver to keep dust and other foreign particles out of the loudspeaker; and also to conceal the loudspeaker cone.

GROMMET. A rubber insulating washer used to prevent a wire from touching the sides of a chassis hole through which the wire passes.

GROUND CLAMP. A metal strap or clamp that is adjustable for making a good electrical connection to any ground rod or grounded pipe. The clamp has a screw terminal or soldering lug to which the ground wire is attached. A good ground is important if it is specified for your receiver.

HALF-WAVE RECTIFIER. A radio tube, or other device, which converts alternating current into pulsating direct current by allowing current to pass only during one half of each alternating-current cycle. A half-wave rectifier contains only one diode section.

HEADPHONES. Small telephone receivers held against the ears by a clamp passing over the head.

HEATER. A filament used in a vacuum tube only for the purpose of supplying heat to an indirectly heated cathode.

HEAVISIDE LAYER. A layer of ionized gas which scientists believe exists in the region between 50 and 400 miles above the surface of the earth, and which reflects radio waves back to earth under certain conditions. It is also known as the Kennelly-Heaviside layer.

HENRY, OR HY. The practical unit for measuring inductance.

HOOKUP. A diagram giving circuit connections for a radio receiver, transmitter, or any electronic device.

HUM. A low and constant audio frequency, usually either 60 or 120 cycles. A defective filter condenser in an a.c. power pack is the usual cause of objectionable background hum in receivers.

IMPEDANCE. The total opposition which a radio part or circuit offers to the flow of alternating, or pulsating direct current at a particular frequency. Impedance is a combination of resistance and reactance, and is measured in ohms.

INDUCTANCE. That property of a coil or other radio part which tends to prevent any change in current flow. Inductance is effective only when varying or alternating currents are present; it has no effect on the flow of direct current. Inductance is measured in henrys.

INDUCTIVE COUPLING. A form of coupling in which energy is transferred from a coil in one circuit to a coil in another circuit by induction. There is no electrical connection between the coils; the coupling is produced by magnetic lines of force.

INTERMEDIATE FREQUENCY. In a superheterodyne receiver, the frequency to which all incoming carrier signals are converted before being fed into the intermediate-frequency amplifier.

INTERMEDIATE FREQUENCY AMPLIFIER. That section of a superheterodyne receiver which is designed to amplify signals with high efficiency at a predetermined frequency called the intermediate frequency of the receiver.

INTERMITTENT RECEPTION. A type of radio receiver trouble in which the receiver performs normally for a time, then becomes dead or distorts the signals, with the process being repeated at intervals.

LEADIN. A wire which serves to connect the outdoor signal pickup portion of an antenna system with the antenna terminal on the receiver.

LIGHTNING ARRESTER. A protective device used to divert directly to ground a discharge of lightning which strikes an antenna.

LINE CORD. A two-wire cable terminating in a two-prong plug used to connect a radio receiver to an a.c. or d.c. wall outlet.

LINE FILTER. A device inserted between the line-cord plug of a radio receiver and the power line to filter out noise signals that might enter the receiver from the power line. It consists of one or more choke coils and fixed condensers.

LOKTAL TUBE. A small glass-type radio tube with special base construction which locks the tube firmly in the corresponding special eight-prong loktal socket. These tubes are used in auto radios and some a.c.-d.c. midget receivers.

LUG. A small strip of metal for placing under a terminal screw to provide a convenient means of making a soldered wire connection.

MAN-MADE STATIC. High-frequency noise signals produced by sparking in electrically operated apparatus, or power lines, and picked up by the receiver, interfering with a desired radio program.

MANUAL TUNING. Tuning a radio receiver by rotating the tuning control knob by hand.

METAL-TYPE TUBE. A vacuum tube having a metal envelope, with electrode connections being made through glass beads fused into the metal envelope. Usually called an all-metal tube.

MICROPHONE. A device which converts sound waves into corresponding audio frequency electrical energy. It contains some form of flexible diaphragm which moves in accordance with sound wave variations. This movement generates a minute voltage which is fed to the input of an amplifier where it is amplified many times.

MILLIAMMETER. A measuring instrument which measures current flow in milliamperes.

MOTORBOATING. Regeneration occurring at audio frequencies in a radio receiver or audio amplifier, resulting in "putt-putt-putt" sounds resembling those made by a motorboat.

NEUTRON. Having neither positive nor negative charge. An uncharged particle of nearly the mass of the proton.

OCTAL BASE. A type of tube socket having eight equally spaced prongs and a central aligning key. When some of the prongs are not required they are omitted without changing the positions of the remaining prongs.

OHM. The practical unit of electrical resistance, being the resistance of a circuit in which a potential difference of one volt produces a current of one ampere.

OHMMETER. A test instrument for measuring resistance.

OSCILLATION. A condition whereby high-frequency currents are generated in a circuit.
OSCILLATOR. The stage in a radio receiver, transmitter or other apparatus in which a vacuum tube and associated components generate alternating-current energy when fed with direct-current energy.
PADDER CONDENSER. In a superheterodyne receiver, this trimmer condenser is connected in series with the oscillator tuning circuit to control the receiver calibration at the low-frequency end of the tuning range.
PARALLEL CONNECTION. A connection in which current divides between two or more parts, as contrasted to a series connection in which the same current flows through all parts. Batteries are connected in parallel by connecting the positive terminals together, and then connecting the negative terminals together.
PENTODE. A vacuum tube having five electrodes. Ordinarily these will be the cathode, control grid, screen grid, suppressor grid and anode (P).
PERMANENT MAGNET. A piece of hardened steel or other magnetic material which has been artificially magnetized and retains its magnetism.
PHILLIPS SCREW. A screw having an indented cross on its head instead of the conventional slot.
PHOTOELECTRIC CELL. A device which converts variations in light into corresponding variations in voltage or current.
POLARITY. In a radio circuit or part, the quality of having two opposite charges, one negative and the other positive.
POTENTIOMETER. A variable resistance unit having a rotating contact arm which can be set at any desired point on the resistance element. The volume control in a radio receiver or audio amplifier is generally a potentiometer.
PROTON. Nucleus of the atom of the light isotope of hydrogen, constituting the principal part of its atomic mass and exhibiting a unit positive charge of electricity.
PUSH-BACK HOOKUP WIRE. Tinned copper hookup wire covered with cotton insulation that can be pushed back from the end of a wire length to expose sufficient wire for a connection.
PUSH-PULL CIRCUIT. A two-tube audio output circuit so designed that both tubes operate simultaneously and their individual audio-frequency plate currents add in the common load to give twice the output of a single tube.
PUSH-PULL TRANSFORMER. An iron-core a.f. transformer designed for use in a push-pull amplifier circuit. If it is the input transformer, it will have a center-tapped secondary winding. If it is the output transformer it will have a center-tapped primary winding.
RADIO FREQUENCY. Any frequency in the radio spectrum above the highest audible frequency, which is about 20,000 cycles. Abbreviated as r.f.
RADIO FREQUENCY AMPLIFIER. A vacuum-tube amplifier stage to provide amplification at radio frequencies. In a tuned-radio-frequency (t.r.f.) receiver all stages ahead of the detector are r.f. amplifier stages.
RADIO FREQUENCY TRANSFORMER. An air-core, or powdered-iron core, transformer used in r.f. circuits.
REACTANCE. Opposition offered to the flow of alternating current by the inductance or the capacity of a part.
RECTIFIER. A device that changes alternating current into pulsating direct current. It may be a vacuum tube, gaseous tube, crystal, vibrator, or a selenium rectifier device.
REGENERATION. The process by which a part of the output power of an amplifying device reacts upon the input circuit in such a way as to reinforce the initial power, thus increasing the amplification. It is sometimes referred to as "feedback."
RESISTANCE COUPLING. A type of coupling in which a resistor and a condenser provide a path for signal energy between two circuits.
RESISTOR. A resistance unit, or "package" of resistance, employed in the control or operation of electrical devices or for their protection from overload.
RESONANCE. In a circuit containing both inductance and capacity, a condition in which the inductive reactance is equal to and cancels out the capacitive reactance at a particular frequency.
RHEOSTAT. A variable resistance unit to control the flow of current.
SCHEMATIC DIAGRAM. A diagram which shows electrical connections of a radio or electronic device by means of symbols which are used to represent the various radio parts.
SENSITIVITY. A measure of the ability of a radio receiver to reproduce weak signals with good volume.
SELECTIVITY. The degree to which a receiver is capable of reproducing the signals of one station while rejecting the signals from all other stations.
SHIELD. A metal can or housing placed around a radio part to prevent its electrical and magnetic fields from affecting nearby parts, or to prevent other fields from affecting it.
SHIELDED WIRE. Insulated wire having around it a shield of tinned braided copper wire.
SHORT CIRCUIT. A low-resistance connection, usually accidental, occurring between the two sides of a circuit, or between any two circuit terminals. It often results in excessive current flow and damage to parts.
SHORT WAVES. Wavelengths shorter than those included in the broadcast band. In other words, waves shorter than 200 meters. Short waves correspond to frequencies higher than the highest broadcast-band frequency of 1600 kilocycles.
SIGNAL GENERATOR. A test instrument used by radio service men and experimenters to produce a modulated or unmodulated r.f. carrier signal having a known radio-frequency value. It is used as a signal source during the alignment of a radio receiver and when checking for a defective part in an improperly working receiver.
SIGNAL TRACING. A radio receiver servicing technique which involves tracing the progress of a radio signal through an entire receiver, stage by stage, while the set is in operation.
SPAGHETTI TUBING. Heavily varnished cloth tubing used to provide additional insulation for radio circuit wiring.
SPIDER. A flexible fiber ring which serves to center the voice coil of a dynamic loudspeaker without hindering the in-and-out motion of the voice coil and its attached diaphragm.
SPLICE. A joint between two wires which possesses mechanical strength as well as good electrical conductivity.
STAND-OFF INSULATOR. An insulator used to support a wire or part at a desired distance away from the building or other support on which the insulator is mounted.
STATIC. Interfering noises heard in a radio receiver due to radio waves created by atmospheric electrical disturbances.
STATOR. The fixed plates in a variable condenser.
STEP-DOWN TRANSFORMER. A transformer in which the secondary winding has fewer turns than the primary, so that the secondary delivers a lower voltage than is applied to the primary.
STRANDED WIRE. A wire which consists of a number of finer wires twisted together.
TEST LEAD. A flexible insulated lead used chiefly for connecting meters and test instruments to a circuit under test.
TEST PROD. A sharp metal point provided with an insulated handle and means for connecting the point to a test lead. Used for making a touch connection to a circuit terminal.
TETRODE. A four-electrode vacuum tube. Ordinarily, these electrodes will be the cathode, control grid, screen grid and anode (P).
TOGGLE SWITCH. A small switch operated by means of a lever.
TONE. The general character of a reproduced radio program as it affects the human ear.
TONE CONTROL. A circuit control on a radio receiver which permits the operator to strengthen the response at either low or at high audio frequencies at will, so as to make the reproduced program pleasing.
TREBLE. A term sometimes used to designate high audio frequencies.
TRIODE. A three-electrode vacuum tube, usually having a cathode, control grid and anode (P).
TUNGAR BULB. A gaseous diode rectifier used in battery chargers.
TUNING. The process of setting all of the tuning circuits in a radio receiver simultaneously to a desired frequency by rotating the tuning dial.
UNIVERSAL OUTPUT TRANSFORMER. An iron-core a.f. output transformer having a number of taps on its windings to permit its use in practically any average radio receiver (matches any output tube).
VACUUM TUBE. A device consisting of a number of electrodes mounted in an envelope, or housing, from which practically all air has been removed. Also called a radio tube or an electron tube.
VOLT. The unit of electromotive force which, steadily applied to a conductor whose resistance is one ohm, will produce a current of one ampere.
VOLTAGE REGULATOR TUBE. A two-element gaseous tube used in a.c. radio receivers to keep the input a.c. voltage to the receiver power pack constant despite wide variations in the line voltage.
VOLTMETER. A meter used to measure electrical pressure in volts.

VOLT-OHM-MILLIAMMETER. A test instrument having provisions for measuring voltage, resistance and current. It employs a single meter having the necessary number of scales, and a switch which places the meter in the correct circuit for a particular measurement.

VOLUME CONTROL. A variable resistor which varies the a.f. output of a receiver or public-address (PA) amplifier, thereby changing the volume of the sound produced by the loudspeaker.

WATT. The practical unit of electrical power. One watt is the power produced by a current of 1 ampere at a pressure of 1 volt. In a d.c. circuit the power in watts consumed by a device is equal to the applied voltage multiplied by the current in amperes.

WIRE-WOUND RESISTOR. A resistor which is made by winding a high-resistance wire on an insulating form, usually ceramic; it may or may not be covered with a ceramic insulating layer.

ZERO BEAT. A condition where two frequencies are exactly the same.

TRANSISTORS

LESS THAN 10 years ago, a new component emerged from one of the nation's top electronic laboratories—a unit that promises to revolutionize the entire industry. It is called the transistor.

The transistor is the tiny device which is threatening the position of the vacuum tube as the basis of all electronics. It can already perform many tube functions—amplification, oscillation, etc.—and it can do the job better, cheaper and more efficiently.

Unlike a vacuum tube, the transistor's elements are entirely embedded in a solid material. As a result, the transistor can take shock and vibrations which would ruin even the most rugged vacuum tube.

In fact, with no filaments to burn out or loose their emission, the operating life expectancy of transistors is over 100,000 hours—far greater than the expected life of the equipment in which they are used.

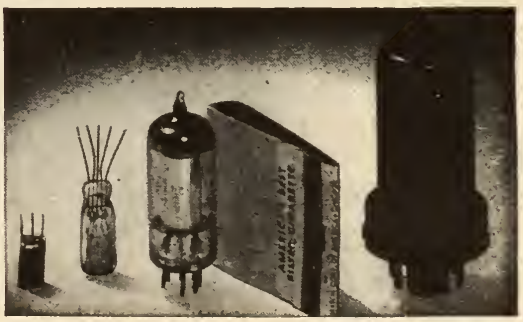
The lack of a filament greatly reduces the power required for the operation of transistor circuits. A few small penlight cells are usually sufficient, and these will last almost as long in the circuit as they would lying unused on the dealer's shelf.

All in all, transistors are destined to play a tremendous and fascinating role in the future of electronics.

Except for the omission of the filament, a typical transistor is very much like the

Simplicity of structure is only one of the many advantages transistors have over their counterparts—the vacuum tube

Tiny transistor, left, is dwarfed by conventional subminiature, miniature and standard vacuum tubes



triode, a three-element tube. Instead of cathode, grid and plate, however, the transistor's electrodes are called *emitter, base* and *collector.* When a very small voltage is applied between the base and the emitter elements of the transistor, a current will flow in the emitter-collector circuit which, with the proper choice of components, can produce a greatly amplified voltage in the output circuit.

SIX-CIRCUIT LAB PROJECT

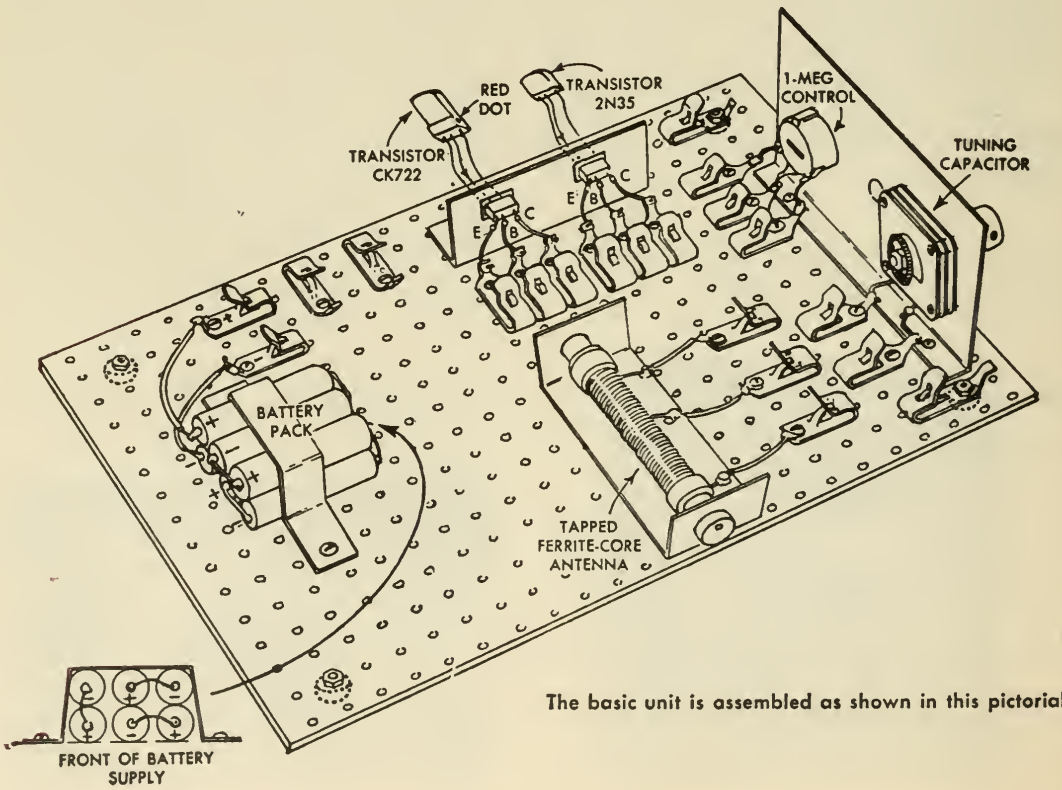
The simplicity of transistor circuits and their advantages over vacuum tubes can easily be demonstrated with a number of easy-to-build projects. The six projects selected here can be constructed with a minimum number of inexpensive parts, yet each one is a practical circuit which will provide excellent performance.

Some of these, including a code-practice oscillator, a simple radio and a more efficient regenerative receiver can be built with only a single transistor. The addition of another transistor and just a few extra parts will permit you to build a more sensitive radio, a photoelectric relay and an electronic metronome.

The basic unit

All six circuits of this laboratory-type project are constructed on a piece of 8 x 12-in. pegboard which serves as a base for mounting the major components. Once these parts are mounted, and their terminals soldered to convenient Fahnestock clips, it is necessary only to insert the proper small parts (including resistors, fixed capacitors and interconnecting wires) into the designated clips in order to change from one circuit to another. This permits repeated use of the same parts without the time-consuming job of soldering and unsoldering the various leads.

Note in the basic unit that the pegboard is supported in each of its four corners by rubber feet. These keep the board slightly above the worktable and provide clearance for the screws and nuts used for mounting the various parts. The parts layout, while not critical so far as circuit operation is concerned, should follow the illustration.



The basic unit is assembled as shown in this pictorial

The original, carefully planned layout permits all resistors and fixed capacitors to be inserted into the proper clips by their own leads.

The brackets mounting the tuning capacitor and control, and the two transistor sockets are made of thin aluminum which can easily be cut and bent. Six penlight cells, wired in series, serve as the power supply for all circuits. These may be replaced by a single 9-volt battery, if desired, to eliminate the rather tedious task of soldering short pieces of wire between the positive and negative terminals of the various cells.

Be careful in mounting the transistor sockets so that the pin spacing is exactly as shown. If the sockets are turned around, you will not obtain proper performance.

LIST OF MATERIALS FOR BASIC CIRCUIT

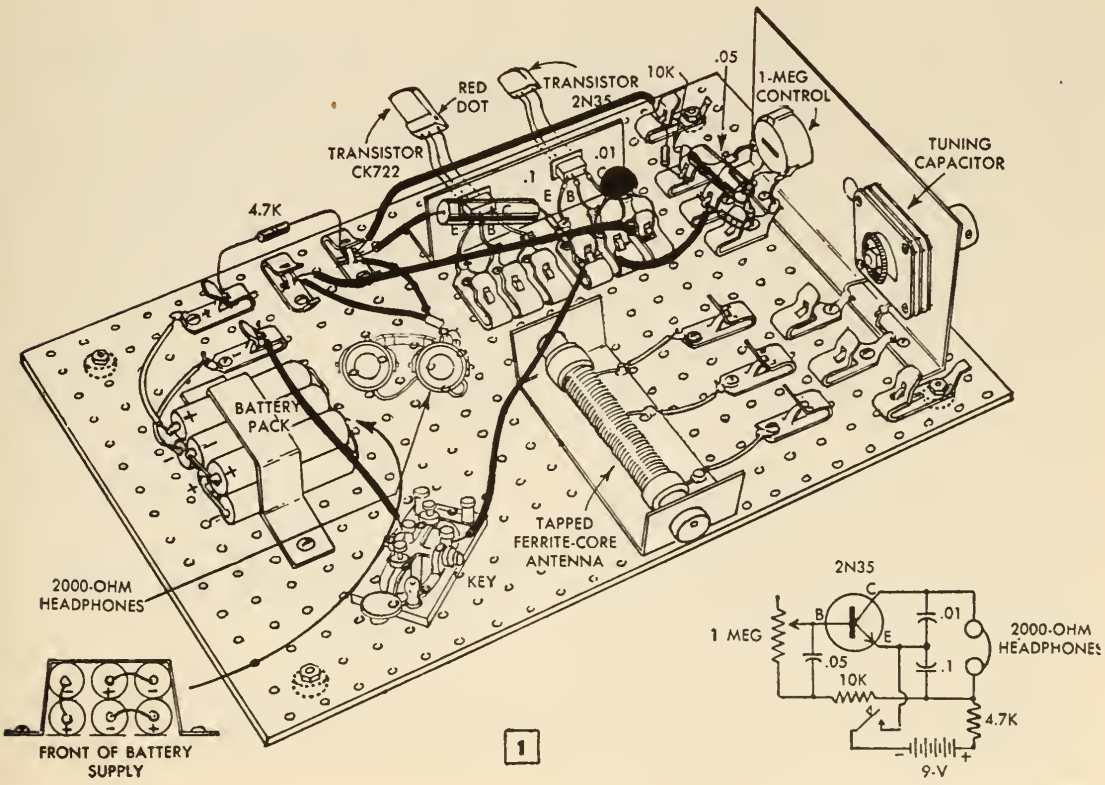
1—Transistor antenna coil, Lafayette Radio No. MS-166
1—Miniature variable capacitor, 365 mmfd., Lafayette No. MS-215 or equivalent
1—Potentiometer, 1 megohm, linear taper
2—Three-pin transistor sockets, Lafayette No. MS-275 or equivalent
6—Penlight batteries or one 9-volt battery
1—Perforated pegboard, 8 x 12 in.
4—Rubber feet
20—Fahnestock clips, $1\frac{1}{16}$ x $\frac{3}{8}$ in.
Assorted machine screws and hex nuts, hookup wire, rosin-core solder, aluminum for mounting brackets.

Circuit 1—code-practice oscillator

Sooner or later, anyone who is seriously interested in radio and electronics as a hobby, will start thinking about getting an amateur radio operator's license. To obtain such a license (call your local Federal Communications Commission office for complete information) you must be able to send and receive code at the rate of at least 5 words per minute. A good code practice oscillator is a practical necessity in learning the code.

This circuit when wired in accordance with Fig. 1 provides an audio tone in the headphones whenever the handkey is depressed. Thus, you can practice the *dits* and *dahs* to your heart's content, without disturbing anyone else in the room. The

Schematic and pictorial diagrams of the code-practice oscillator.



1

CONTINENTAL (INTERNATIONAL MORSE) CODE

A	dit-dah
B	dah-dit-dit-dit
C	dah-dit-dah-dit
D	dah-dit-dit
E	dit
F	dit-dit-dah-dit
G	dah-dah-dit
H	dit-dit-dit-dit
I	dit-dit
J	dit-dah-dah-dah
K	dah-dit-dah
L	dit-dah-dit-dit
M	dah-dah
N	dah-dit
O	dah-dah-dah
P	dit-dah-dah-dit
Q	dah-dah-dit-dah
R	dit-dah-dit
S	dit-dit-dit
T	dah
U	dit-dit-dah
V	dit-dit-dit-dah
W	dit-dah-dah
X	dah-dit-dit-dah
Y	dah-dit-dah-dah
Z	dah-dah-dit-dit

1	dit-dah-dah-dah-dah
2	dit-dit-dah-dah-dah
3	dit-dit-dit-dah-dah
4	dit-dit-dit-dit-dah
5	dit-dit-dit-dit-dit
6	dah-dit-dit-dit-dit
7	dah-dah-dit-dit-dit
8	dah-dah-dah-dit-dit
9	dah-dah-dah-dah-dit
0	dah-dah-dah-dah-dah

Period	
Comma	
Question mark	
Error	
Double dash (BT)	
Wait (AS)	
End of message (AR)	
Invitation to transmit	
End of work (SK)	

Period	dit-dah-dit-dah-dit-dah
Comma	dah-dah-dit-dit-dah-dah
Question mark	dit-dit-dah-dah-dit-dit
Error	dit-dit-dit-dit-dit-dit-dit-dit
Double dash	dah-dit-dit-dit-dah
Wait	dit-dah-dit-dit-dit
End of message	dit-dah-dit-dah-dit
Inv. to transmit	dah-dit-dah
End of work	dit-dit-dit-dah-dit-dah

tone can be adjusted to the most pleasing pitch by varying the resistance of the potentiometer. If the lowest pitch available with the components used is still too high, you can lower the range further by adding another .01 mfd. capacitor in parallel with the one already in the circuit. This will provide a considerable change in pitch.

The 2N35 transistor is used in this circuit. This is an N-P-N type unit which requires a positive voltage on the collector electrode. The CK722 transistor (P-N-P type), used in some of the other circuits, requires a negative collector voltage. An accidental interchange of the two might result in damage to the transistor.

Before installing the transistor in the socket, its leads should be cut to approximately ¼ in. Then, make sure that the transistor leads are inserted in the correct socket holes, as indicated by the spacing of the leads. Failure to heed this precaution might also damage the unit.

Before closing the key, carefully check your wiring. Each wire must be held firmly in place in its clip if proper operation is to be obtained. Any bare wire leads which might contact other wires or clips should be covered with spaghetti tubing to eliminate the possibility of short circuits. When properly wired, the oscillator should begin to operate the instant the key is closed.

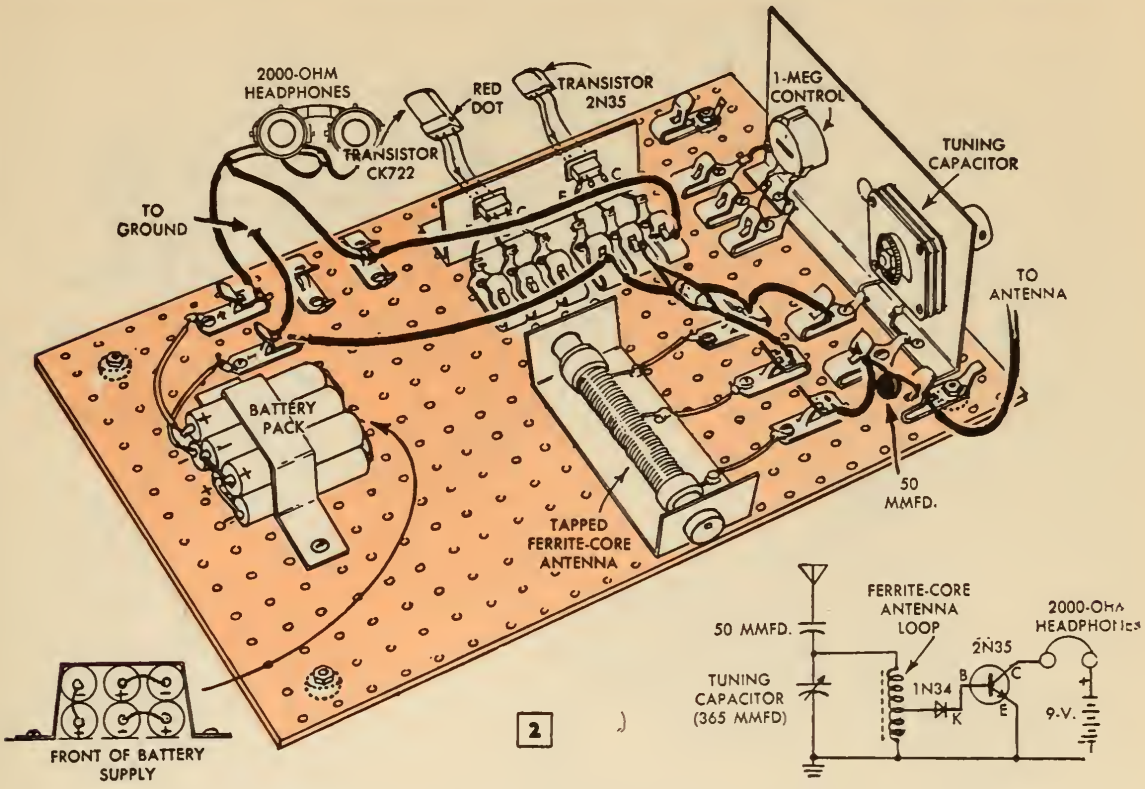
The Continental International Code used in radio consists of short signals, called dots, and long signals, called dashes. To reproduce a dot with the code-practice oscillator, merely depress the key for a short instant. To make a dash, the key should be depressed about three times as long as for a dot.

The code symbols representing the letters of the alphabet, as well as numbers and punctuation marks are listed above.

MATERIALS FOR CODE-PRACTICE OSCILLATOR

in addition to items used in basic circuit

1—Sylvania 2N35 transistor
1—.01 mfd. capacitor (any type)
1—.1 mfd. capacitor
1—.05 mfd. capacitor
1—10,000-ohm, ½-watt resistor
1—4700-ohm, ½-watt resistor
1—2000-ohm magnetic headset
1—Telegraph key



The schematic and pictorial diagrams of the second lab project—the simple, one-transistor receiver

Circuit 2—a simple radio

In spite of its simplicity, this receiver, Fig. 2, is capable of excellent headphone volume when used with an outdoor antenna and a good ground. It consists of a crystal set, followed by a stage of transistor audio amplification. The signals picked up by the antenna are coupled through a 50-mmfd. capacitor to the tuned circuit consisting of the antenna coil and the tuning capacitor. Here the desired station is separated from the others, and its r.f. signal is detected by the crystal diode. The resulting audio is amplified by the transistor before being applied to the headphones.

Since the transistor draws only a very small amount of current from the batteries, an on-off switch is not required. But, when the receiver is not in use, the headphones may be disconnected to break the power supply circuit and prevent any current flow.

In wiring the set, special attention must be given to the crystal diode. It is essential that the cathode end of the diode be inserted into the base clip of the transistor. While a 1N34 diode is specified in the parts list, any other similar unit may be used. In all diodes the cathode terminal is labeled either by the letter K, a broad stripe or by a small schematic symbol like the one shown in the schematic diagram of Fig. 2.

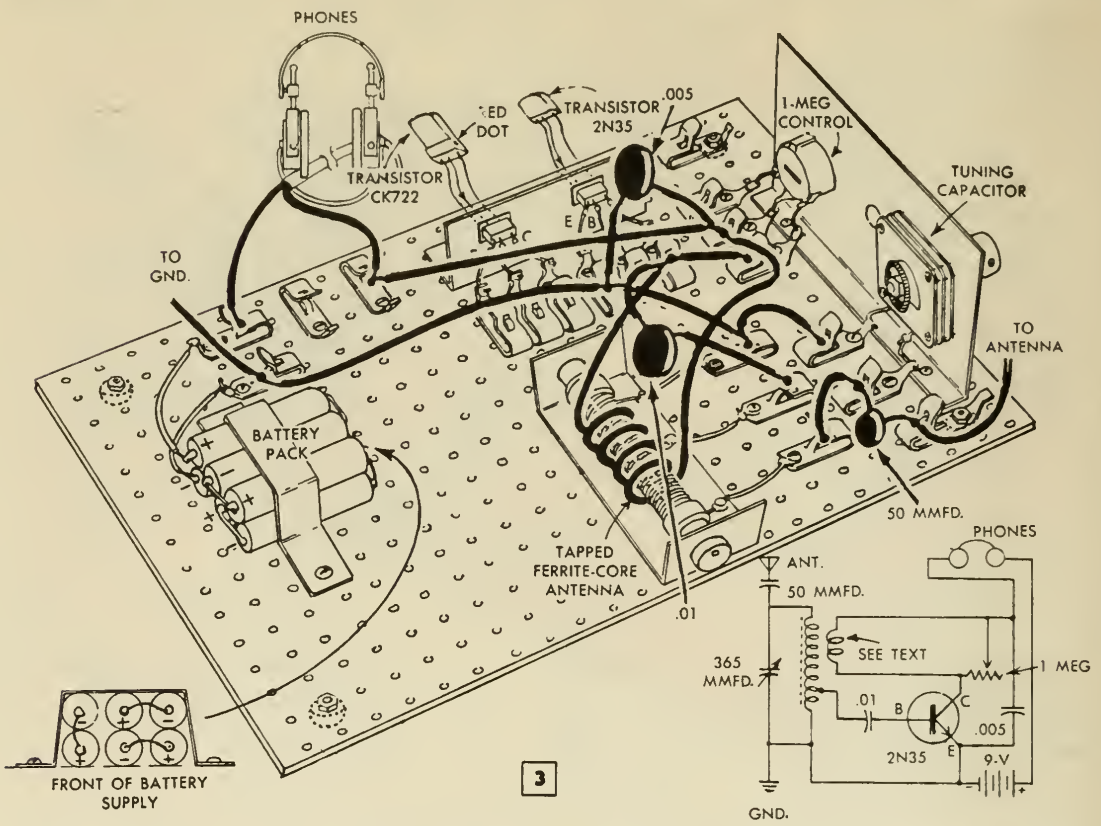
LIST OF MATERIALS FOR SIMPLE RADIO

in addition to items used in basic circuit

1—1N34 crystal diode
1—Sylvania 2N35 transistor
1—2000-ohm magnetic headset
1—50-mmfd. capacitor

Circuit 3—regenerative receiver

By adding a small amount of regeneration, or positive feedback, to the simple receiver in circuit two, the sensitivity of the set can be greatly improved. However, this new circuit, Fig. 3, is much more difficult to tune than the previous one. You will find that even a slight misadjustment of the control will produce howls, squeals and whistles in the headphones and may cause



The schematic and pictorial diagrams of lab project No. 3—the one-transistor, regenerative receiver

interference to other nearby radios. Nevertheless, the regenerative circuit is one of the most efficient ever devised, and proper adjustment of the receiver will result in excellent performance.

In comparing the schematic diagram, Fig. 3, with the previous one, you will notice that the crystal diode has been replaced with a .01 mfd. capacitor. In this circuit, the transistor itself detects the r.f. signal and the diode is not needed.

LIST OF MATERIALS FOR REGENERATIVE RECEIVER

in addition to items used in basic circuit

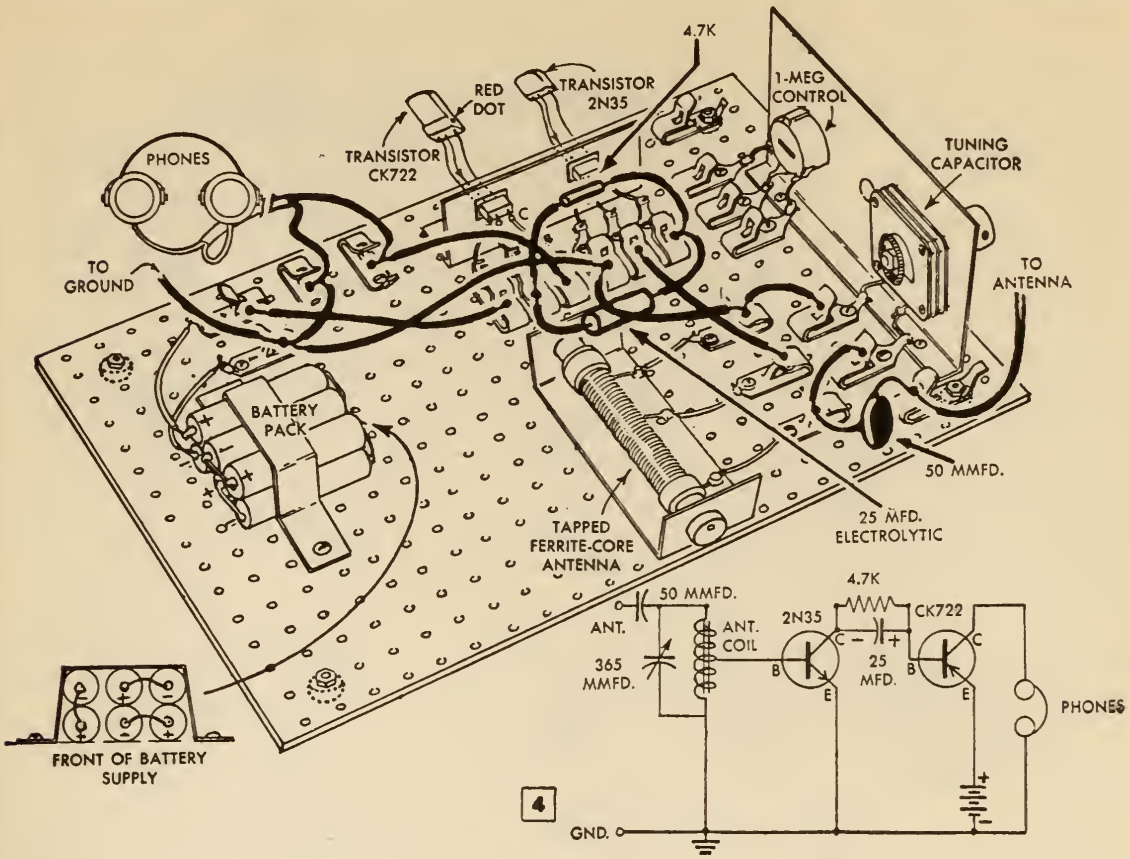
1—Sylvania 2N35 transistor
1—50-mfd. capacitor
1—.01-mfd. capacitor
1—.005-mfd. capacitor
1—2000-ohm magnetic headset

However, an extra coil winding has been added in the collector circuit. This coil consists of 8 or 10 turns of ordinary hookup wire wound around the antenna coil as shown in the pictorial diagram. The amplified r.f. signal currents flowing through this coil are induced back into the antenna coil by magnetic coupling between the two windings so that they are repeatedly reamplified before being detected in the base-emitter circuit. This results in a much greater audio signal than could be obtained with only the normal amplification of the transistor.

The 1-megohm potentiometer across the feedback winding can be adjusted to prevent excessive feedback which would cause the circuit to oscillate. This adjustment is quite critical if maximum amplification without oscillations is to be obtained.

After the circuit has been wired, rotate the control until a howl or whistles are heard in the phones as the tuning capacitor is varied. Then, back off with the control until the whistles just disappear. This is the most sensitive setting.

If there are no whistles as the control is rotated, interchange the wires of the feedback coil in the control clips. You can also experiment with the number of turns of the feedback winding until you obtain best results.



Two-transistor radio. A 1N34 diode between coil and transistor as in Fig. 2 may improve performance

Circuit 4—simple two-transistor radio

The addition of a second amplifier stage to the circuit of Fig. 1 provides greater volume than even the regenerative receiver, without the associated tuning difficulties. The new circuit and the proper wiring are shown in Fig. 4.

While a good antenna and ground are still required for best results, it is quite possible that you can obtain satisfactory reception of the stronger stations by clipping a short antenna lead to a metal window screen, bed springs or the finger stop of a dial telephone.

If you are so inclined, you may experiment a little further by combining this second stage of audio amplification with the regenerative detector described previously for even greater increase in amplification.

LIST OF MATERIALS FOR TWO-TRANSISTOR RADIO

in addition to items used in basic circuit

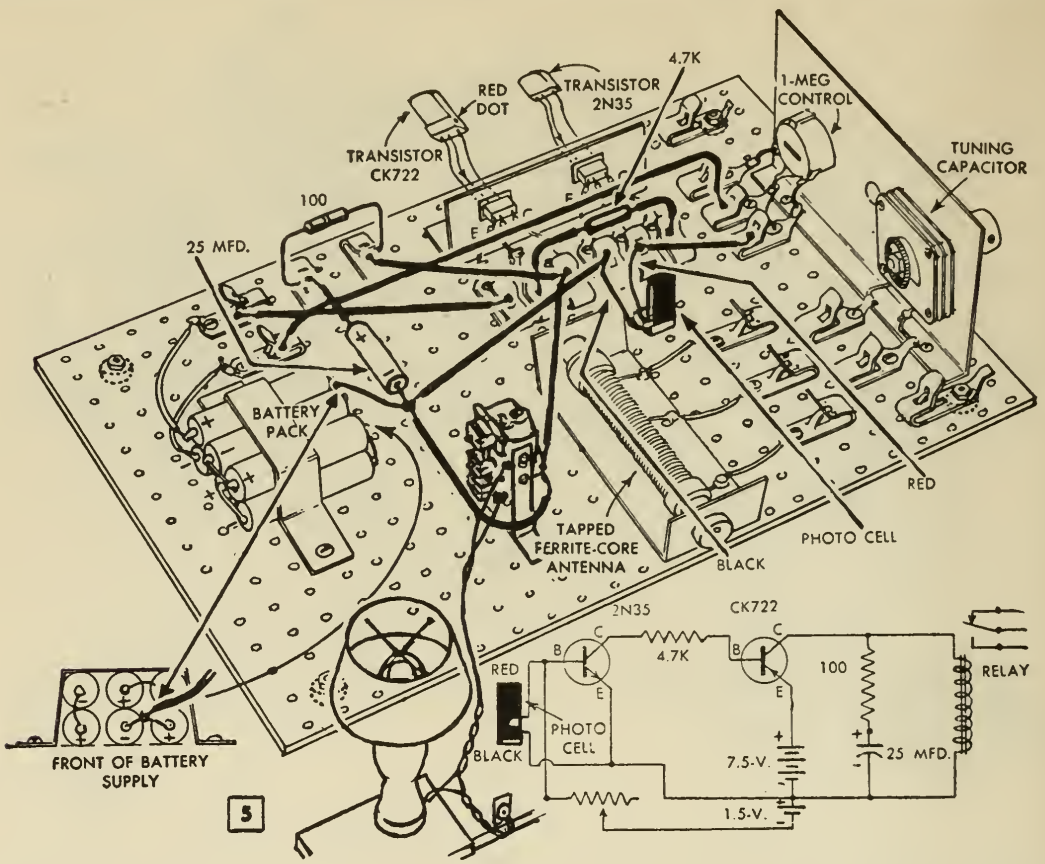
1—Sylvania 2N35 transistor
1—Raytheon CK722 transistor
1—50-mmfd. capacitor
1—25-mfd./12-volt electrolytic capacitor
1—4700-ohm, ½-watt resistor
1—2000-ohm magnetic headset

Circuit 5—sensitive photoelectric relay

Here is a photoelectric switch employing two transistors and a photoelectric cell.

The pictorial wiring diagram and the schematic for this circuit are shown in Fig. 5. The photocell is connected to the input of a direct-coupled, two-transistor amplifier which is capable of amplifying direct as well as alternating current. In this circuit, the collector of the 2N35 transistor is powered by only five of the six penlight cells in the battery pack. The sixth cell is used for bias.

If you have used a single, 9-volt battery in wiring the basic unit, you can obtain the required bias voltage from a separate 1.5-volt flashlight cell wired in series with the 9-volt unit.



Photoelectric relay schematic and pictorial. Connections show how the relay can be wired to turn on a lamp

LIST OF MATERIALS FOR PHOTOCELL RELAY

in addition to items used in basic circuit

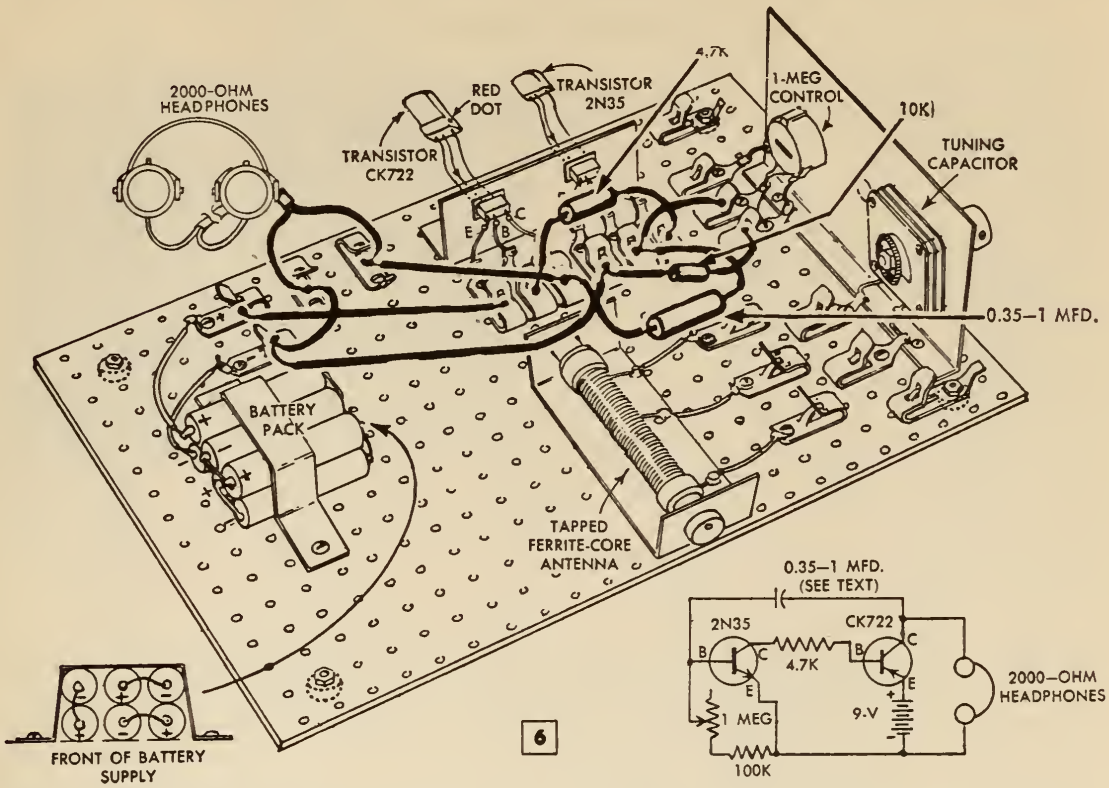
1—Sylvania 2N35 transistor
1—Raytheon CK722 transistor
1—S.p.d.t. relay, Advance No. SO/1C/4000D or equivalent
1—25-mfd./12-volt electrolytic capacitor
1—100-ohm, ½-watt resistor
1—4700-ohm, ½-watt resistor
1—Selenium photocell, International Rectifier Corp. No. B2M

As a result of the bias, no current flows in the base-emitter circuit of the first transistor. When light strikes the photocell, this unit generates a voltage of its own which tends to counteract the bias and causes the base current of the transistor to increase. This current increase is amplified in the two transistors so that it will be great enough in the CK722 collector circuit to close the relay.

The setting of the 1-megohm control determines the amount of light which must strike the photocell to cause the relay contacts to close.

The relay recommended in the parts list is a single-pole, double-throw (s.p.d.t.) unit. It is possible, therefore, to use the relay to turn some external device on or off when light strikes the photocell.

If you wish to cause the relay to turn on a lamp with the coming of darkness, for example, the connections illustrated in the pictorial diagram can be made. To do this, cut one of the wires of the two-conductor lamp cord and connect one of the open ends to the center contact of the relay. The other open end is then connected to the normally closed contact. (Inspect the relay contacts closely before wiring the circuit to determine which is the normally closed contact.) Now, with the circuit wired as shown, plug the line cord of the lamp into the wall outlet and turn the lamp switch on. In a normally lit room, you should be able to turn the lamp on and off by rotating the 1-megohm control. Set this control to



Schematic and pictorial of electronic metronome. This unit provides accurately timed clicks in headphones

the point where the lamp just goes out, and then cover the photocell with your hand. When this is done, the lamp should light. A little experimentation should enable you to obtain just the right control setting which will turn the lamp on at the desired level of darkness.

Caution: When the circuit is wired and the lamp cord plugged in, the full line voltage (110 volts) will appear across the relay contacts. Be especially careful not to touch the relay while experimenting with this circuit.

If you enclose the photocell in a simple cardboard tube, the tube will act as a shield to keep out undesired light. You can then activate the system with a flashlight beam. The use of the proper relay contacts and correct adjustment of the control will enable you to turn an external device on or off whenever the beam is broken.

Circuit 6—electronic metronome

Every music student is familiar with the mechanical metronomes which provide the "beat" so necessary in practicing music lessons. The circuit in Fig. 6 serves the same purpose by supplying accurately timed clicks in the headphones. The frequency of these clicks is adjustable over a wide range by varying the setting of the potentiometer.

The feedback capacitor connected between the base of the 2N35 and the collector of the CK722 determines the frequency limits which can be obtained by varying the control. If the slowest rate obtainable with the recommended value is still too fast, replace the capacitor with one having a higher value (or add another capacitor in parallel with the original one). The exact capacitor value is not critical and a little experimenting will enable you to adjust the unit to your particular speed.

LIST OF MATERIAL FOR ELECTRONIC METRONOME

in addition to items used in basic circuit

1—Sylvania 2N35 transistor
1—Raytheon CK722 transistor
1—100,000 ohm, ½-watt resistor
1—4700-ohm, ½-watt resistor
1—2000-ohm headset
1—0.35 to 1 mfd. capacitor (as required for proper speed)

FOUR-TRANSISTOR POCKET RADIO

Transistors and sub-miniature components are combined in this radio which is truly pocket-sized but capable of big-set performance. No external antenna or ground is needed for this little midget, yet broadcast-band stations come in with more than adequate volume, even many miles from the nearest transmitter. Don't confuse this set with one including a regenerative circuit which is so often employed in pocket receivers. This unit is a modern, powerful superheterodyne with all the sensitivity and selectivity characteristic of such circuits. Designed specifically as a personal portable, the radio is ideally suited for use with a tiny earpiece. Thus, you can listen to your favorite programs no matter where you go or what you may be doing.

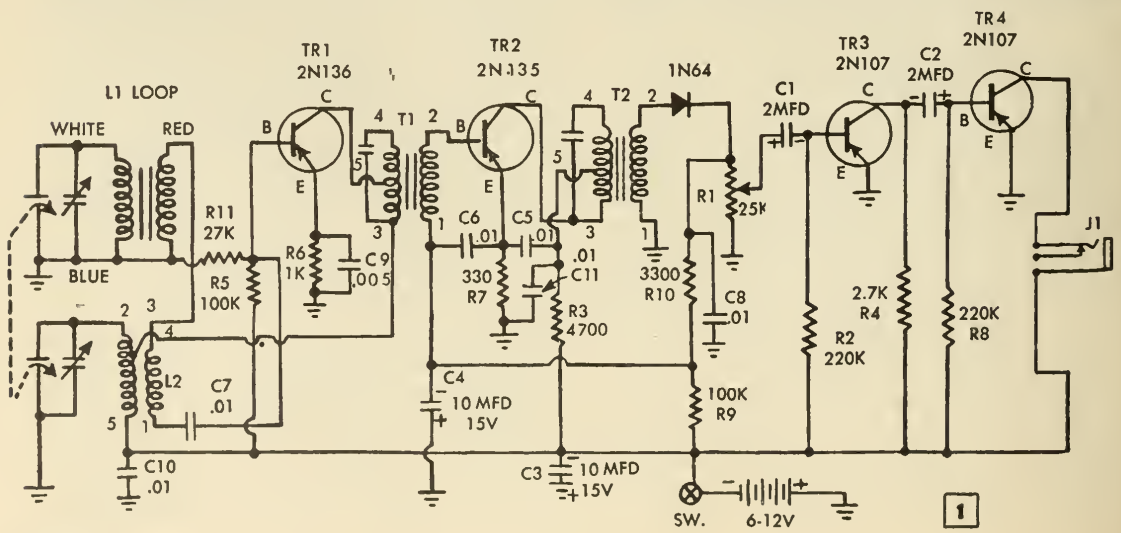
The schematic diagram of the receiver is shown in Fig. 1. Radio signals which are picked up by the highly efficient ferrite-core antenna loop are mixed with those of the oscillator circuit in the 2N136 converter stage, TR1. The resultant intermediate-frequency signal of 455 kc. is amplified by the 2N135 i.f. amplifier and detected by a 1N64 crystal diode. After being separated from the i.f. carrier, the audio signal is further increased in strength by two 2N107 stages of audio amplification before being applied to the earphone. A single 9-volt battery supplies all of the power needed for the entire set.

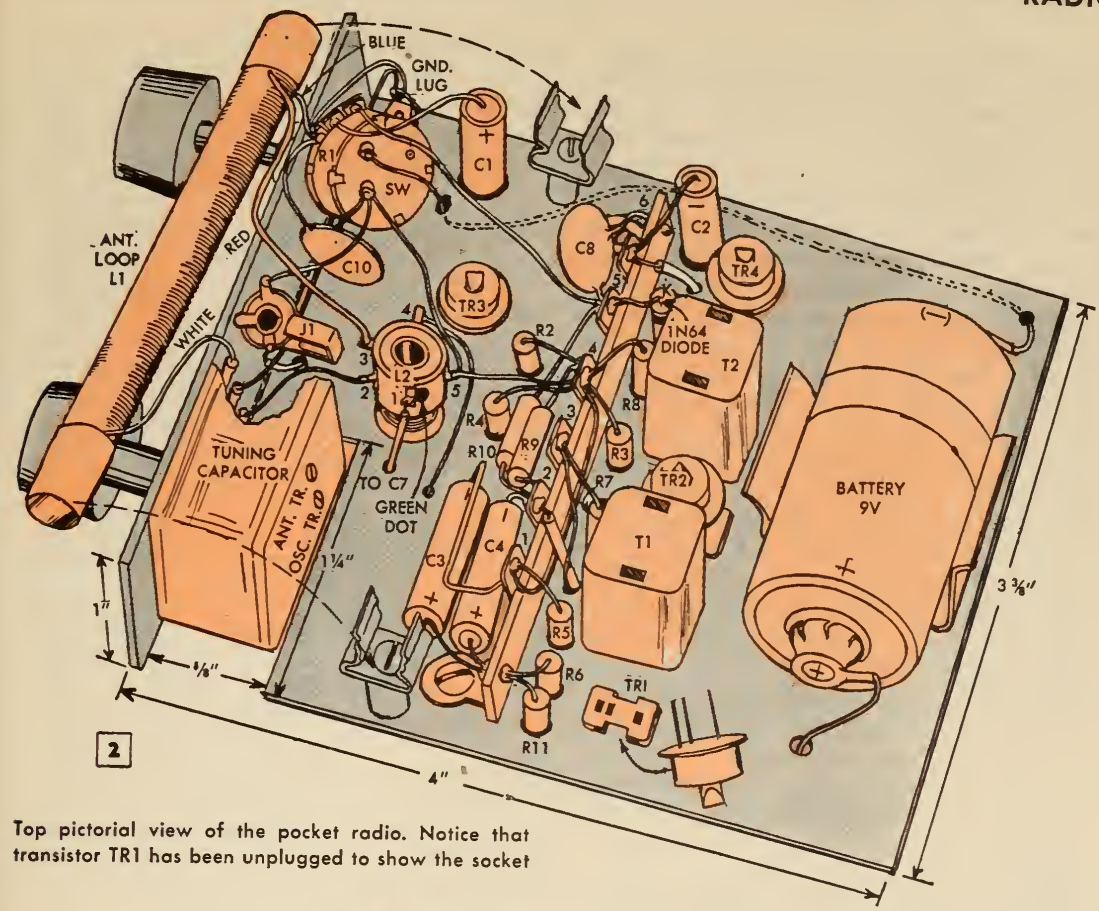
Note comparative size between this pocket transistor radio and matchbook. Earpiece is in the foreground

Construction

The complete radio is built on a home-made aluminum chassis, only 4 in. long, 3⅜ in. wide and 1 in. high. In spite of its small size, however, there is no crowding of components due to the unique through-chassis mounting of some of the small parts. Still, a certain amount of skill in the use of a solder gun or iron, and reasonable care with the chassis layout is required in order to turn out a creditable job. Parts placement is shown in the pictorial diagrams, Figs. 2 and 3. Begin the layout by marking the locations of the necessary holes and cutouts on a flat piece of 1/16-in.

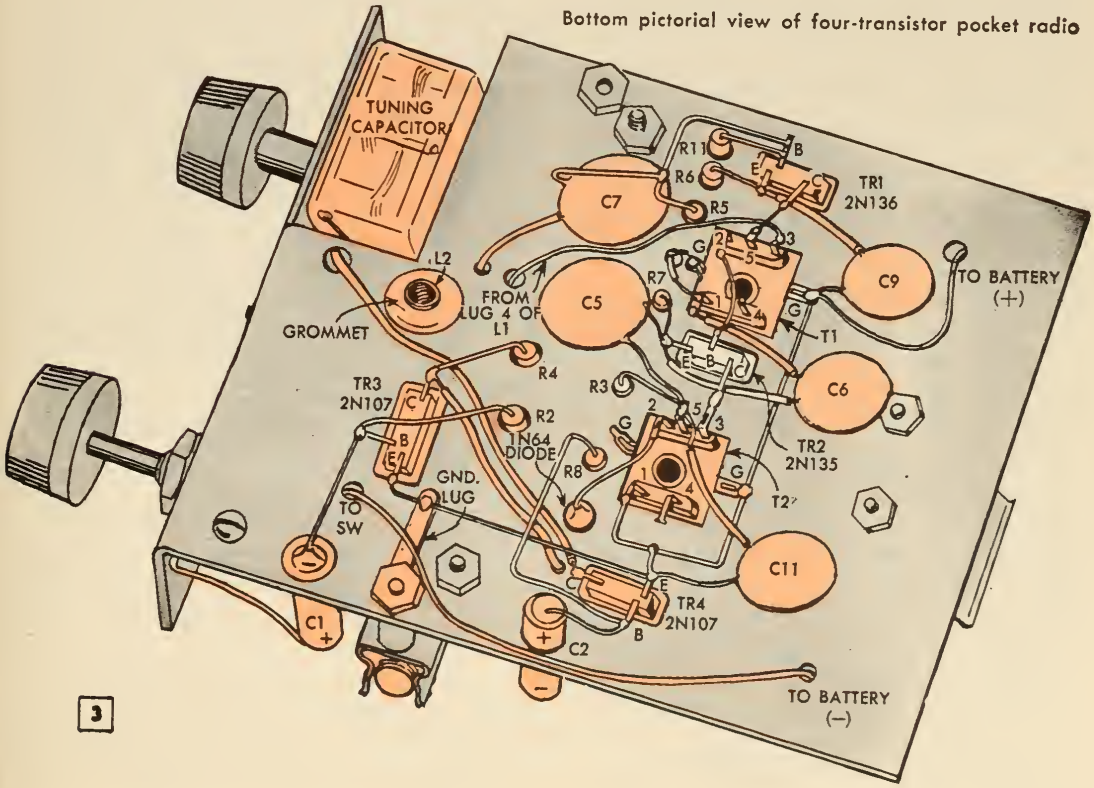
The schematic diagram of the four-transistor, personal, pocket radio. Pictorials are shown on following page





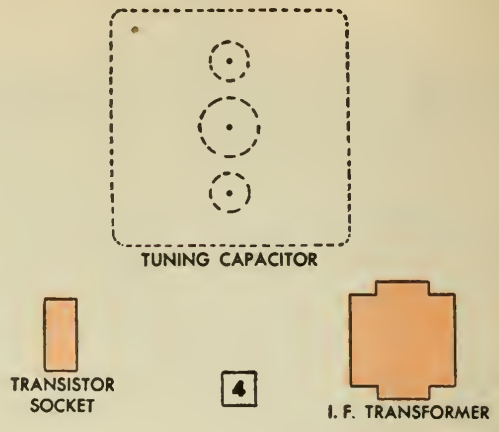
Top pictorial view of the pocket radio. Notice that transistor TR1 has been unplugged to show the socket

Bottom pictorial view of four-transistor pocket radio



aluminum. Then drill and cut the chassis, as required, before bending the 1-in. front lip. Be sure to leave enough space between the terminal strip and the i.f. transformer cans so that the various through-chassis parts can be installed. Exact-size templates for the transistor sockets and i.f. transformer cutouts, as well as for tuning-capacitor mounting holes, are given in Fig. 4.

When mounting the output jack, J1, be sure to insulate it from the chassis by means of the fiber washers supplied with the unit. Fasten the transistor sockets to the chassis with their retainer clips after making certain that they are properly installed. It is important that the two closely spaced socket lugs representing the emitter and base electrodes be positioned as indicated. If the i.f. cutouts have been properly made, these cans will fit snugly into the holes. They are, then, securely held in position by bending their ground lugs (marked "G" in the under-chassis view) so that these are flush with the underside of the chassis. Further rigidity is given this assembly by a ground bus wire running through these lugs to a ground lug especially installed for this purpose. Again, it is important to mount these cans in the positions illustrated.



LIST OF MATERIALS

Capacitors

Tuning capacitor—Miniature 2-gang variable cap., osc. section 100 mmfd., max.; ant.-section 208 mmfd., max., Lafayette Radio, No. MS-270
C1, C2—2 mfd. 6 volt, sub-miniature, electrolytic, Lafayette Radio No. CF-100 or equivalent
C3, C4—10 mfd. 15 volt, sub-miniature, electrolytic, Lafayette Radio No. CF-122 or equivalent
C5, C6, C7, C8, C10, C11—.01 mfd., disk, ceramic
C9—.005 mfd. disk, ceramic

Resistors

R1—25,000-ohm potentiometer with switch, Lafayette Radio No. VC-25 or equivalent
R2, R8—220,000 ohms, ½ watt
R3—4700 ohms, ½ watt
R4—2700 ohms, ½ watt
R5, R9—100,000 ohms, ½ watt
R6—1000 ohms, ½ watt
R7—330 ohms, ½ watt
R10—3300 ohms, ½ watt
R11—27,000 ohms, ½ watt

Coils and transformers

L1—Loop antenna, ferrite-core, tapped, Lafayette Radio No. MS-272
L2—Miniature oscillator coil Lafayette Radio No. MS-265 or equivalent
T1—Transistor i.f. input transformer Lafayette Radio No. MS-268
T2—Transistor i.f. output transformer Lafayette Radio No. MS-269

Transistors

TR1—GE 2N136
TR2—GE 2N135
TR3, TR4—GE 2N107

Miscellaneous

1—Crystal diode, type 1N64
1—Miniature phone jack with insulating washers, Lafayette Radio No. MS-282 or equivalent
1—Matching phone plug, Lafayette Radio No. MS-281 or equivalent
1—9-volt battery, R.C.A. type VS-309 or equivalent
4—Three-prong transistor sockets, Lafayette Radio No. MS-275 or equivalent
2—Miniature knobs to fit shafts of volume control and tuning capacitor (⅛ and ¼ in. holes)
1—Battery mounting clip
1—Grommet for mounting oscillator coil
2—Battery snap-on connectors
1—Six-lug terminal strip
2—Ground lugs (solder lugs)
2—⅜-in. spacers and clips for mounting antenna loop
1—5 x 3⅜-in. piece of aluminum for chassis base
1—Dynamic earphone, Lafayette Radio No. MS-260 or equivalent
Assorted machine screws and hex nuts, hookup wire and rosin-core solder.
All items for this receiver, including the necessary hardware, are available from Lafayette Radio, 100 6th Ave., New York, N. Y.

When all of the parts are mounted. the actual wiring can begin. The use of small diameter No. 22 solid hookup wire is recommended. Comparison between Figs. 2 and 3 will enable you to determine the connecting points of all small parts.

The bare wire leads of all components should be covered with insulating spaghetti tubing to prevent possible short circuits. Make sure that all parts and wires have been connected to a specific terminal before soldering. And then, use only enough solder to insure a good connection. Large gobs of solder may hide cold-solder joints or cause short circuits between adjacent connections.

Lug No. 1 of the oscillator coil can be identified by a green dab of paint. Excessive heat applied to these connections while soldering will damage the small wires of the windings. This applies also to the terminals of the i.f. transformers and to the leads of the 1N64 diode. Observe polarity when wiring the diode and the electrolytic capacitors into the circuit.

The last part to be wired is the antenna loopstick. Leave the color-coded leads of this unit long enough so it can be plugged into its clips without stretching leads.

When all wiring is completed, insert the battery (be sure to observe polarity), and turn the set on. Plug the earpiece into the output jack and insert the 2N107 transistor, TR4, into its socket. The leads of the transistors may be cut off to about ¼ in. *Note: The spacing of the transistor leads corresponds to the spacing of the socket holes. Incorrect insertion may damage the units.* As the transistor is plugged in, you should hear a soft click in the earpiece. If there is no click, turn the set off, remove the transistor and carefully check your wiring and the battery polarity.

Plug the remaining transistors, TR3, TR2, TR1, into their sockets in that order. Each time a transistor is plugged in, listen for a click in the earpiece. By the time you are through, you will probably also hear a soft hiss when the volume control is advanced to its maximum position. You should then be able to tune in some of the stronger stations by rotating tuning knob.

Adjustments

Due to factory alignment of the coils, the receiver should provide satisfactory performance immediately. However, some slight adjustment may be required for optimum result. A plastic or fiber alignment rod is required for "touching up" the i.f. transformers. Do this by first tuning the set to a point where no station is heard. Then turn the i.f. adjustment slugs (through the bottom of each transformer) slightly in both directions. Best adjustment is at the point where maximum hiss is heard in the earpiece.

Now, rotate the tuning capacitor from one extreme to the other to make certain that the receiver covers the entire broadcast band, from 550 kc. to 1600 kc.

Unless you have a signal generator you may not be able to determine if the receiver is covering the entire band since very few localities have broadcast stations at both extremes. But, you should be able to tune in the various stations in your area. If the receiver does not pull in the highest-frequency stations, adjust the oscillator trimmer screw, Fig. 2, until that station is heard when the tuning capacitor is nearly open. Then, adjust the antenna trimmer screw for maximum volume. You will probably have to take the loop antenna out of its clips to make these adjustments.

If the set does not receive the lowest-frequency stations when the tuning capacitor is nearly closed, adjust the slug inside the oscillator coil until the station is heard. You will then have to readjust the oscillator and antenna trimmers, at the high end. Since all of these adjustments affect both ends of the band, this procedure may have to be repeated several times to obtain best results.

The carrying case

You will probably wish to install the receiver in some sort of enclosure. Small, commercially available plastic boxes are ideal for this purpose. The exact mounting method depends upon the size of the case and your own preference. One possible method consists of mounting a small ¼-in. spacer between the bottom of the case and the underside of the chassis. The assembly of case, spacers and chassis is fastened together with flat-head machine screws and matching hex nuts. If the holes are countersunk in the bottom of the case, the mounting screws will be flush with base.

The control shafts are long enough to protrude through the case, but the hole for the earphone jack may have to be oversized to permit proper insertion of the plug.

BULLS-EYE TUNING WITH YOUR RADIO

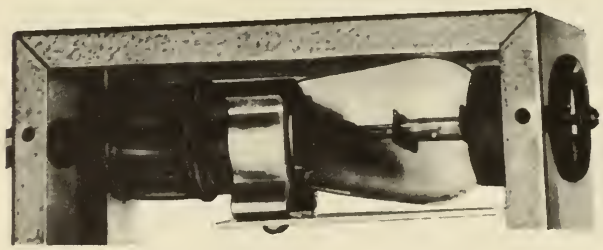
By Rudolf F. Graf

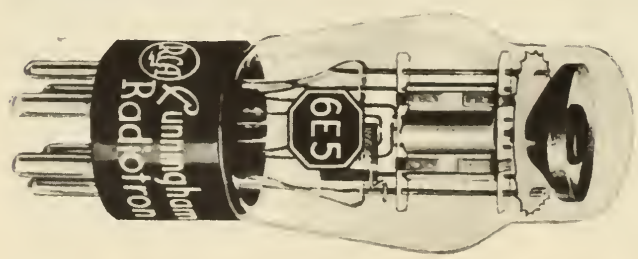
FOR HIGHEST QUALITY reception of AM and FM radio broadcasts the receiver must be tuned exactly to the carrier frequency of the desired station. Some of the more expensive radio sets incorporate some sort of tuning indicator which permits easy, on-the-nose tuning, but a good many receivers are not so equipped. As a result, such sets are difficult to adjust and are often left in a detuned position which causes a great deal of distortion and listener fatigue. The addition of a tuning indicator will greatly improve their performance.

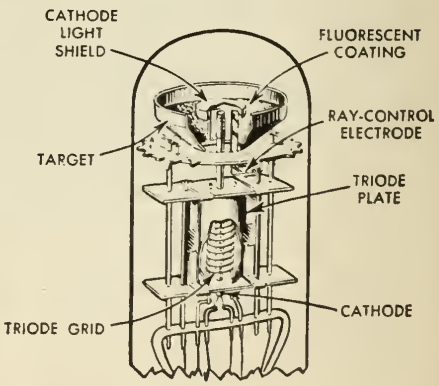
The easily constructed tuning indicator shown here employs the popular and inexpensive 6E5 electron-ray tube illustrated below. The cut-away illustration of Fig. 1 shows the essential parts of the tube. Here's how it works.

The target, a funnel-shaped piece of metal at the head of the tube, is coated with a fluorescent chemical which gives off a green glow when bombarded with a stream of electrons. It is connected to a positive d.c. voltage in a receiver and thus attracts the electrons emitted from the heated cathode. In the absence of a control voltage the electrons strike all parts of the target, giving it the appearance of a green ring of light.

Located between the target and the cathode is a small piece of wire which serves as a ray-control electrode. When this electrode is at the same potential as the target it has no effect on the electron stream. If, however, the electrode is negative with respect to the target it will repel the electrons in its vicinity, effectively keeping them from reaching the target. As a result, the target area directly behind the electrode does not glow, causing the familiar pie-shaped shadow.







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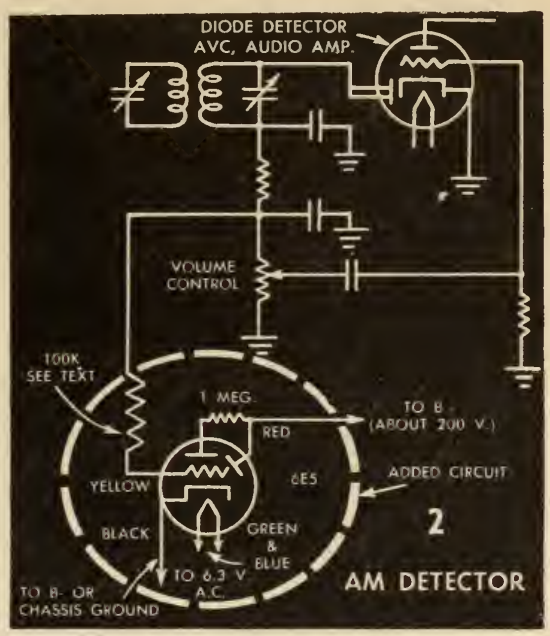
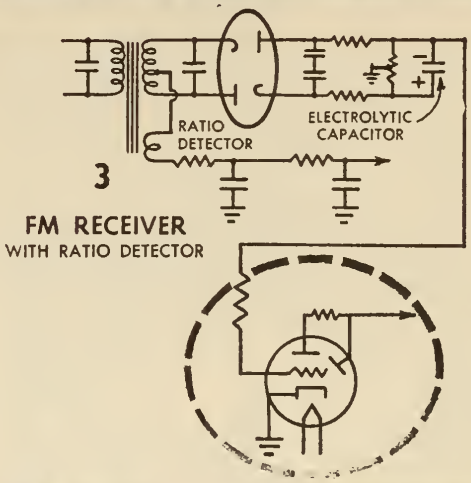
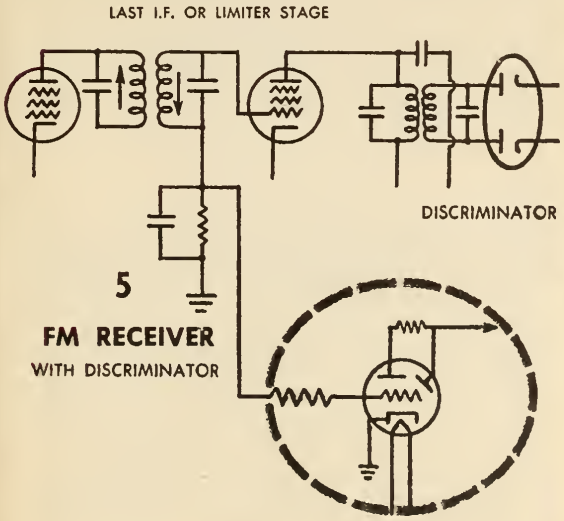
The size of the shadow is proportional to the voltage difference between the target and the ray-control electrode. For the tube to act as a tuning indicator, therefore, it is merely necessary to connect its control grid to a point in the receiver where the voltage varies in accordance with the signal strength. Such a point exists in all modern AM and FM radios.

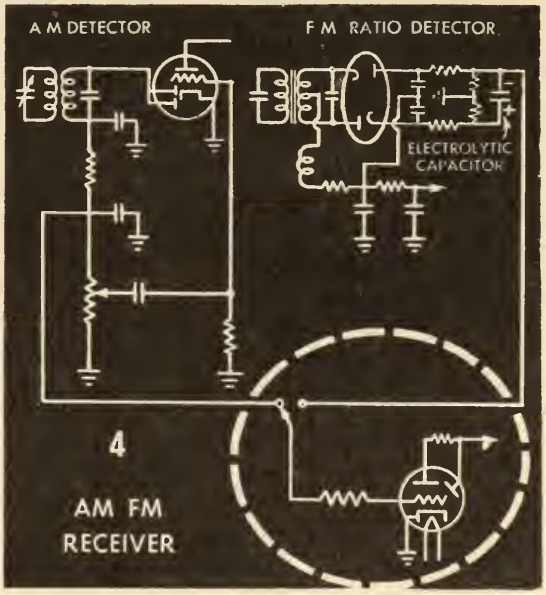
Construction of the tuning indicator is simplicity itself. The required parts— the 6E5 tube, the Amphenol 58-MEA-6 Tuning Eye Mounting Assembly and a small aluminum box (Bud, CU2106A) are inexpensive and are available from most large radio parts distributors or dealers. The mounting assembly is supplied with bracket, escutcheon, light shield and socket. Five color-coded wires emanating from the back of the socket are sufficiently long to reach the back of most any receiver when the completed tuning indicator is placed on top. It is merely necessary to mount the tube and assembly inside the box (this requires the drilling and punching of 4 holes in the box) and to connect the 5 wires to the appropriate points within the receiver. If desired, the receiver can be outfitted with an appropriately wired 5-prong socket, and a matching plug wired to the tuning-eye wires, so the two units can easily be interconnected or separated.

Making the proper connections within the receiver requires some knowledge of radio circuitry—at least the ability to read and follow schematic diagrams. These connections, for various types of sets, are shown in Figs. 2 through 5. It will be noted that the green and blue filament leads of the 6E5 require 6.3 volts of a.c. This restricts the use of the tuning indicator to









transformer-operated receivers where this voltage is available from the filament winding of the power transformer. For AC-DC sets, an inexpensive 6.3-volt filament transformer can be separately installed.

No modifications or changes in the receiver circuit are required. It is merely necessary that the tuning-indicator leads be connected to the correct points within the set. The red wire, from the target of the 6E5, goes to B-plus (any value of filtered d.c. voltage between 150 and 250 volts will do) and the black cathode wire goes to ground (the chassis in transformer-powered sets—the negative lead of the filter capacitor in AC-DC receivers).

The yellow wire from the grid of the 6E5 triode section must be connected to a point in the receiver which provides a negative d.c. voltage, varying in accordance with the strength of the received signal. In AM receivers, Fig. 2, this is the top (ungrounded end) of the volume control; in FM sets with ratio detectors it is the negative terminal of the electrolytic capacitor shunting the detector load resistor, Fig. 3.

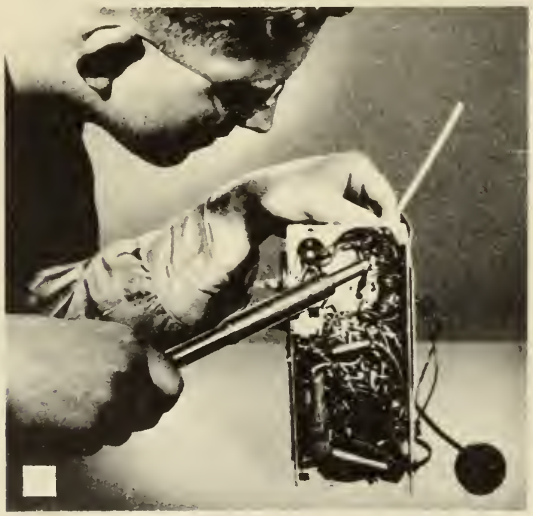
Fig. 4 shows the use of a s.p.d.t. switch to connect the tuning indicator to either the AM or FM section of a combination FM-AM receiver. The switch may be mounted directly on the receiver chassis.

Some of the more expensive FM receivers use a discriminator circuit rather than a ratio detector. Such a circuit is always preceded by one or more limiter stages. In such sets the yellow wire is connected to the R-C filter network in the grid circuit of the last limiter stage, Fig. 5. If in doubt as to the kind of detector used in your FM set, consult a schematic diagram.

Normally, the yellow lead from the tuning indicator can be directly connected to the proper point in the receiver. In some cases however, the addition of a 100K, ½-watt isolation resistor, as shown, will give a sharper indication, though it is not absolutely essential. The 1-megohm resistor shown between triode plate and target of the 6E5 is already wired in place in the Amphenol mounting assembly. This resistor need not be installed separately.

Properly wired, a pie-shaped shadow of about 100 deg. will appear on the indicator tube when the receiver is turned on but not tuned to a station. As a station is tuned in, the "eye" will close. Correct setting is indicated by maximum closing of the "eye."

By providing a visual indication of signal strength, the tuning indicator greatly simplifies tuning and makes radio listening far more enjoyable. ★ ★ ★



HINTS FOR RADIO SET OWNERS

A—Wax from warm condensers and transformers often runs down into tube sockets and causes poor contact when tubes are replaced. By heating terminals and inserting pipe cleaner, wax may be removed

B—Case for sun glasses used to carry spare miniature tubes. A partition that protects the glasses from breakage also provides protection for the tubes when they are wrapped in paper for carrying

C—Plastic toy scissors, available at dime stores, can be made to serve as a handy insulated radio tool. By filing notches near the ends as shown, the suspected loose wiring can be pulled for testing

CHEAPSKATE

A two-transistor radio for beginners and more advanced experimenters

By Forrest H. Frantz, Sr.

WHAT KIND OF RECEPTION can you expect from just two transistors? Not very much—when you're talking about the usual type of receiver consisting of a detector and a couple of amplifier stages. Normally, that type of radio requires an external antenna and ground to deliver earphone volume even on local stations.

But when a circuit is designed to take optimum advantage of all possibilities, you can expect something better. "The Cheapskate," for example, is an attempt to get the most for the least—most reception at the lowest cost. The result is a two-transistor set, small enough to fit into your pocket, yet sensitive enough to pull in stations 10 or 15 miles away with only the built-in antenna. What's more, the stations can be adequately separated and do not interfere with one another—a major disadvantage of the detector-amplifier type of receiver.

The Cheapskate owes its sensitivity and selectivity to a first stage which is, at once, regenerative and reflexed. Regeneration provides repeated amplification of the radio-frequency signal, up to the point of oscillations, and greatly increases the efficiency of the first stage as an r.f. amplifier. At the same time, reflexing causes this stage to perform double duty. Not only does it amplify the r.f. signal picked up by the antenna, but it also serves as an audio amplifier. This is accomplished by applying the detected signal, or audio, back to the input of the first transistor. As a result, the two transistors of the Cheapskate actually do the work of three.

But even the Cheapskate won't give you something for nothing. Though highly efficient, it suffers from the same malady that has forced the discontinuance of regenerative circuits in ordinary broadcast receivers. It is critical in its tuning.

Since the sensitivity of the receiver is largely a function of the amount of regeneration, proper adjustment of the regeneration control, C2, is important. Too much regeneration will cause the receiver to oscillate and howl like a banshee. Too little reduces the amplification to the point

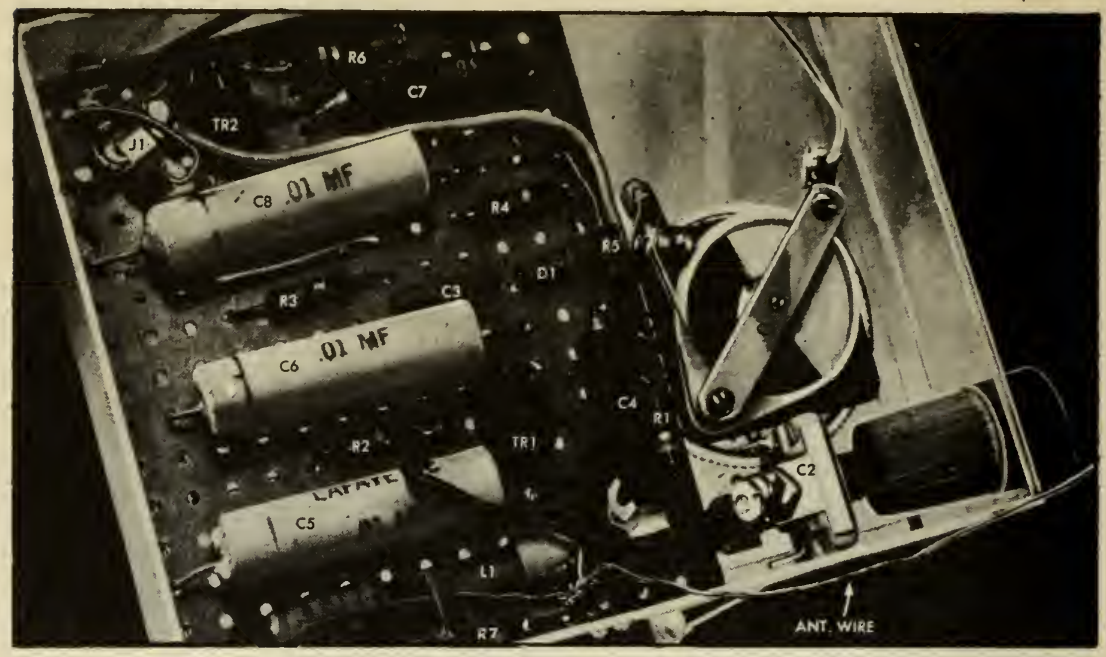


Fig. 1. Top of perforated Bakelite chassis shows parts placement. Ant. wire is glued to inside of case

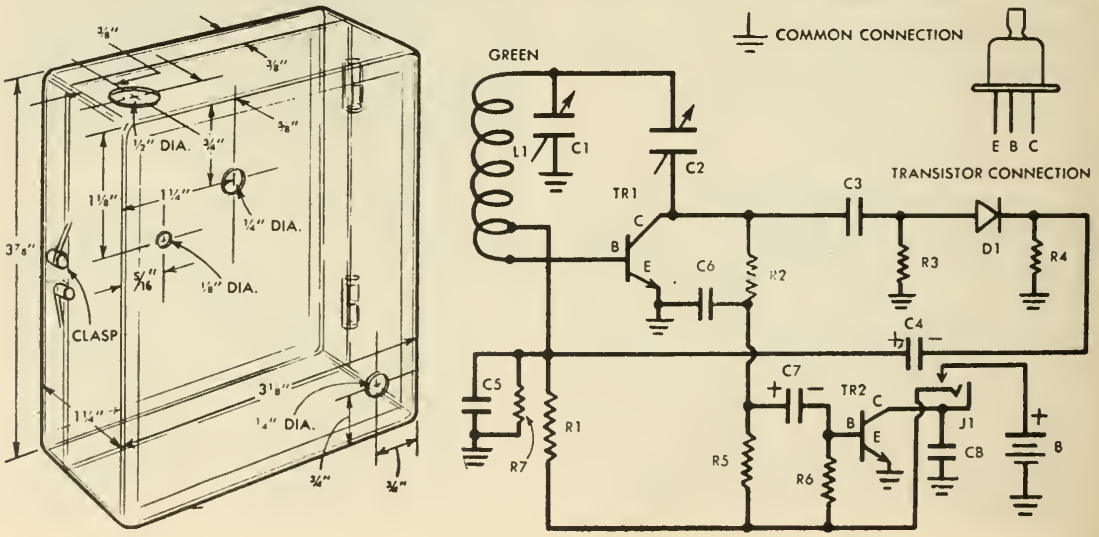
where you may not hear anything at all. But with a little practice and care in tuning, the Cheapskate performs very well indeed, and provides a rewarding construction project for both beginners and more experienced hobbyists.

Building the Cheapskate is a job that anyone handy with a soldering iron can complete in one or two evenings. The parts (including batteries and earphone) are easily obtainable and cost less than $10. The use of a plastic-case housing and perforated Bakelite mounting board eliminates the need for metal-cutting tools and simplifies construction.

Fastening the various parts inside the plastic case requires 4 mounting holes (see Fig. 2.) The holes in the thin plastic material can be made easily by starting small pilot holes with a heated ice pick and reaming these to the correct size. For a professional appearance, the inside of the case may be painted with either brush or spray.

The photo in Fig. 1 shows the positioning of all parts on the mounting board. The board suggested in the list of materials is of the correct width but must be cut to a length of 3⅛ in. to fit snugly into the case. The small parts are fastened to the board by routing their pigtail leads through the small holes and bending them underneath. Before fastening them in place, however,

Fig. 2. Plastic case layout, left, and schematic wiring diagram, right, for simple Cheapskate receiver



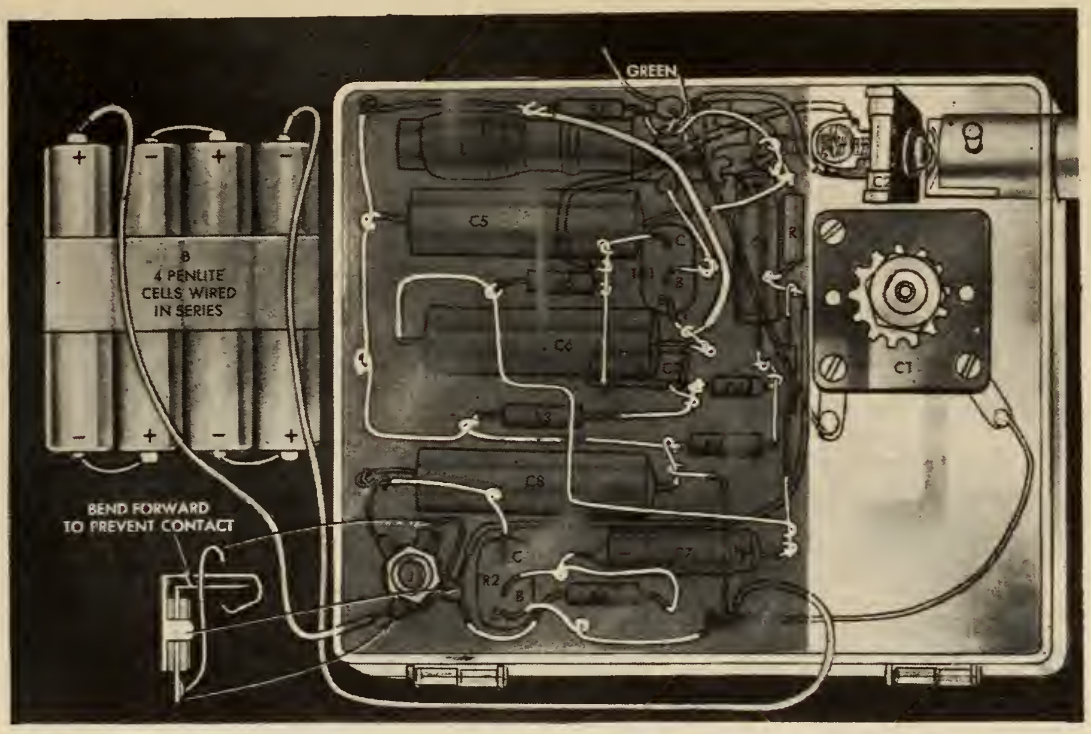


Fig. 3. Pictorial wiring diagram shows wiring and parts placement through "transparent" mounting board

lay the board inside the case to locate the center for the phone-jack hole. The location of this hole must correspond with that in the case, but it is made somewhat larger —$\frac{1}{16}$ in.—so that it will pass the jack collar. Otherwise the jack bushing will not protrude through the front of the case.

The pictorial wiring diagram in Fig. 3 shows the mounting board as if it were transparent, permitting you to see the parts on one side and the wiring on the other. Close adherence to this diagram, followed by a careful check of your wiring against the schematic shown in Fig. 2. should result in a unit very similar to that of the original model.

All connections must be securely soldered with a good grade of rosin-core solder. Double check your placement of the two transistors and the diode, D1, before soldering their leads. Note the unequal spacing of the three transistor leads. Compare the transistor identification diagram in Fig. 2 with the pictorial in Fig. 3 to make sure that the transistors are correctly positioned on the board. Reversing them would result in their destruction when battery voltage is applied.

When soldering the transistor and diode wires, grip the leads with long-nosed pliers between the solder junction and the body of the unit. The pliers act as a heat sink and prevent the heat from the iron from damaging these heat-sensitive parts.

Before mounting the phone jack, modify it as shown in the small inset of Fig. 3 so that it acts as an on-off switch. This is done by bending the normally closed leaf of the jack away from the plug-contact element so that the two do not make contact at any time. Then, solder a short piece of wire to the center lug of the jack and bend this wire around the back as shown. There should be a slight amount of clearance between the end of this wire and the back of the jack—enough so that there is no contact until the headphone plug is inserted. With insertion of the plug, the jack element will be pushed back to make contact with the wire and complete the battery circuit. When the plug is removed, contact will be broken and the battery circuit opened. This provides a simple, yet effective, switch and causes the receiver to be turned on automatically when the earphone is plugged in.

The Vari-Loop antenna coil, L1, is supplied with a bracket which is not needed for mounting purposes. It does come in handy, however, for fashioning a knob for the regeneration control, C2. Cut off a piece of this bracket, about ½ in. long, and solder it into the screw slot of the capacitor, C2. Do not permit the solder to flow down the capacitor plates. The rest of the knob consists of a 1-in. length of ⅜ or ½-in.-dia. dowel fitted through the hole in the top of the plastic case. A saw slot in the bottom end of the dowel fits over the metal piece so that the dowel acts as an extension

which permits adjustment of C2 from the outside of the case.

Since the plastic case is easily damaged by a hot soldering iron, all solder connections should be made before any parts are fastened to the case. This includes a piece of hookup wire, about 3 in. long, soldered to the heavier of the two lugs on capacitor C2. It is this lug which will be fastened to the case with a screw and nut.

Before fastening the subassemblies to the case, unravel the short length of copper wire which is soldered to one lug of L1. This wire can be glued to the inside of the case after all parts are installed. Final assembly will be simplified by mounting first C2—with screw and nut—then the fully wired mounting board—held in place with the phone-jack nut—and finally, the tuning capacitor, C1. A tuning dial, together with a polished-metal center which screws into the capacitor shaft, is supplied with this unit.

The battery, a 6-volter, is made by connecting four Penlite cells in series. Wrap the four cells with cellulose tape so that they are in line with one another and solder jumper wires to adjacent cells as shown in Fig. 3. But keep the amount of heat, and the time it is applied, to a minimum in the interest of long battery life. Make sure that the battery is connected exactly as shown because improper battery polarity will not only prevent operation of the set, but may ruin the transistors. After connecting the battery to the circuit, tape it securely to the inside of the plastic case cover.

Now you're ready to try the Cheapskate. Plug in the earphone and increase the capacity setting of C2, by tightening the screw, until the receiver starts to oscillate (squeal) or motorboat (a put-put sound). Rotate the tuning dial throughout its range. There should be a whistle in the earphone every time you tune past a station.

Tune in a station, as indicated by the whistle, and slowly loosen the screw of C2 until the whistle just disappears. This is the most sensitive adjustment of the set and the station should now be audible. You will have to readjust the tuning dial slightly to bring in the station with maximum volume.

The antenna loopstick is directional, and rotating the receiver may increase the volume still more. The regeneration control will have to be readjusted for each station.

The coil, L1, and capacitor, C1, combination should provide satisfactory operation over the whole broadcast band. If you are unable to tune in stations near the low end of the band, turn the screw in L1 clockwise so that the slug moves farther into the coil. If you can't get all high-frequency stations, rotate the screw counterclockwise.

Considering its simplicity and low cost, the Cheapskate is a "hot" little set. While it can't be compared with more elaborate and expensive "superhets," it is nevertheless perfectly adequate for private listening to local stations. ★ ★ ★

LIST OF MATERIALS

RESISTORS: (All resistors are ½-watt, ±10% carbon units. K=1000 ohms). R1=270K; R2=1K; R3, R4=15K; R5=4.7K; R6=220K; R7=47K.

CAPACITORS: C1=tuning capacitor (365 mmfd.) with dial knob, Lafayette MS-445; C2=35-mmfd. mica trimmer capacitor; C3=100 mmfd. ceramic or mica; C4, C7=30 mfd., 6 v. miniature electrolytic; C5, C6, C8=.01 mfd. tubular.

SEMICONDUCTORS: TR1=GE 2N168A (NPN) transistor; TR2=GE 2N170 (NPN) transistor; D1=Raytheon 1N66 diode.

MISCELLANEOUS: L1=Transistor Vari-Loop antenna coil, Lafayette MS-299 or equiv.; dynamic earphone (2000-ohm impedance) with matching plug and jack, Lafayette MS-368 or equiv.; plastic case, 3⅞ x 3⅛ x 1⅛ in., Lafayette MS-298; perforated Bakelite board; Lafayette MS-304; B=4 RCA VSO-74 Penlite cells (connect in series).

Masking tape applied around wires during circuit changes helps identify leads. A pen or soft pencil may be employed as a marker for the tabs. Masking tape makes good insulator if wires aren't rubbing

When you place a transistor in its socket, there isn't always room for fingers. Pliers often substitute, but if too much pressure is used, damage may occur. An easy solution is to use tweezers instead